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Title of Dissertation: "The Role of Food Proximity in Eating Behavior and Body Mass Index Among Air Force Personnel"

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Doctor of Philosophy Degree

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **23 FEB 2009**	2. REPORT TYPE	3. DATES COVERED **00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE **The Role Of Food Proximity In Eating Behavior And Body Mass Index Among Air Force Personnel**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Uniformed Services University of the Health Sciences,4301 Jones Bridge Rd,Bethesda,MD,20814**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
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15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**171**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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TITLE: "The Role of Food Proximity in Eating Behavior and Body Mass Index Among Air Force Personnel"

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ABSTRACT

Over half of active duty military personnel are overweight (Bray et al., 2006). Compared to non-overweight status, overweight status is associated with greater health risk, poorer health status, and lower physical fitness. Although much research to date has examined individual factors associated with overweight, the role of environmental factors has received less attention. The purpose of the proposed study was to examine the extent to which objective and perceived food proximity to base food outlets is associated with both military base food consumption frequency and body mass index among military personnel. Participants were 192 Air Force personnel stationed at Andrews AFB who worked in buildings with different proximity to base food outlets. Personnel underwent a height and weight assessment and completed an anonymous survey regarding 1) frequency of eating away-from-home foods both on and off base, and 2) factors believed to influence eating behavior or body mass index (e.g., lifestyle, occupational, and demographic factors). The sample consisted of primarily enlisted (90.5%), married (55.5%), Caucasian (58.4%), overweight or obese (73.0%) men (80.6%). Respondents reported eating food from base food outlets an average of 5.2 times per week (*SD* = 4.7).

Personnel who worked in buildings with closer proximity to the majority of food outlets on base reported eating food from them more often than personnel who worked in buildings farther away from those food outlets. However, there was no significant association between workplace proximity and BMI. Contrary to expectation, there was no significant association between base food consumption frequency and BMI. Nonetheless, military personnel appear to be eating food from base food outlets fairly often, suggesting that promoting healthy food options on base may help improve diet quality and help prevent weight gain a population level. Interventions might include offering price incentives for healthy food options at base food outlets and unit snack areas, and contracting with vendors who offer more healthy items on their menus. Future research should assess actual food consumption, include a measure of body fat, and examine how these results may generalize to military women, officers, and normal weight personnel as well as deployed settings.

The Role of Food Proximity in Eating Behavior

and Body Mass Index Among Air Force Personnel

by

Capt Crescent A. Seibert, USAF

Dissertation submitted to the faculty of the

Department of Medical and Clinical Psychology

Graduate Program of the Uniformed Services University

of the Health Sciences in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

2009

Acknowledgements

I would like to thank a number of individuals who have helped me through the dissertation process. I would first like to thank my advisor, Dr. Tracy Sbrocco, for her wisdom, mentorship, and encouragement. I would also like to thank Dr. David Krantz for chairing my committee and for his wisdom. I would also like to thank CDR Mark Stephens for his military expertise, mentorship, and thoughtful comments and suggestions as a committee member. I am also grateful to Dr. Marian Tanofsky-Kraff as a committee member and thoughtful input. I also appreciate the advice and mentorship by the following individuals during the early formulation stages of the process: Lt Col Mark Bates, Lt Col Jay Stone, LCDR Christine Hunter, Maj Dana Whelan and Maj Jeffrey Goodie. I also would like to extend a special thank you to Lt Col Catherine Reardon for putting me in touch with commanders and unit points of contact at Andrews AFB and for making this project possible. I am also grateful to Dr. Cara Olsen, Dr. Martin Sherman, and Chiao-Wen Hsiao for their statistical assistance. I also would like to thank Lt Col Jane Heetderks-Cox and Mr. George Miller for their consultation and helpful information regarding food service and food procurement in the Air Force. I would like to thank MAJ Andrew Hagemaster, CPT Laurel Cofell, and Elena Spieker for assisting me with running my participants. I would like to thank the Sbrocco Lab, including Robyn Osborn, Robert Clark, and Anthony Intravaia, for their continual support and encouragement.

Finally, I would especially like to thank my friends and family, and particularly my husband, Dave, who was always there when I needed support and without whom completion of this project and this chapter in my life would not have been possible.

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I. BACKGROUND

Definition of Overweight

The most common index for body fat is body mass index (BMI), which is calculated as weight in kilograms divided by height in squared meters (CDC, 2007). According to the National Heart, Lung, and Blood Institute (NHLBI) guidelines (NHLBI, 1998), overweight is defined as having a BMI of 25 – 29.9 kg/m^2 and obesity is defined as having a BMI $\geq$ 30 kg/m^2. However, it is common in the literature for all individuals with a BMI $\geq$ 25 kg/m^2 to be classified as overweight (i.e., many researchers do not distinguish between overweight and obese categories). Therefore, for the purposes of this literature review, the term "overweight" refers to a BMI $\geq$ 25 kg/m^2 (which includes both overweight and obese by this definition), and the term "obesity" refers to a BMI $\geq$ 30 kg/m^2.

Prevalence and Consequences of Overweight in the General U.S. Population

According to data from the National Health and Nutrition Examination Surveys (NHANES), the prevalence of overweight in the general U.S. population has increased from 56% in 1995 to 66% in 2004 (Flegal, Carroll, Ogden, & Johnson, 2002; Ogden, Carroll, Curtin, McFowell, Tabak, & Flegal, 2006). Overweight is more common among men (70.8%) and older individuals than women (61.8%) and younger individuals, respectively (Ogden et al., 2006). However, African American women (81.6%) and Mexican American women (74.5%) appear to be at greatest risk (Ogden et al., 2006). Overweight has been associated with increased risk for a number of health conditions, including hypertension, sleep apnea, Type 2 diabetes, heart disease, stroke, high cholesterol, stroke, and colon cancer (CDC, 2007). Costs attributed to overweight in the

United States totaled an estimated $75 billion in 2003 (Finkelstein, Fiebelkorn, & Wang, 2004).

Prevalence of Overweight in the Military

As the rate of overweight continues to rise in the United States, (Ogden et al., 2006), many U.S. military members also continue to struggle with overweight. According to the 2005 DoD Survey of Health-Related Behaviors, the prevalence of overweight increased from 50.0% in 1995 to 60.5% among active duty military personnel (Bray, Hourani, Rae Olmsted, Witt, Brown, Pemberton, et al., 2007). Surprisingly, the prevalence of overweight among active duty military personnel is only about 8% lower than the percent overweight in the general U.S. population (Ogden et al., 2006). Interestingly, this increased prevalence in overweight occurred despite higher rates of self-reported exercise (i.e., percent of personnel who reported exercising for at least 20 minutes at least three times per week increased from 65.4% in 1995 to 70.2% in 2002; Bray, Rae Omstead, Willaims, Sanchez, & Hartzell, 2006). Further, a positive relationship has been found between physical activity and BMI among military personnel, suggesting that dietary intake and other health behaviors may be more influential in weight gain than lack of exercise per se (Lindquist & Bray, 2001).

In addition to a rise in percent overweight, prevalence of obesity (i.e., having a BMI $\geq$ 30 kg/m^2) appears to be rising among military personnel. For example, the prevalence of obesity among active duty Army personnel was 5% in 1999 (Pfizer Pharmaceuticals, 1999). However, the more current 2003 report indicated a 15.3% prevalence of obesity among active duty Army personnel (National Quality Management Program, 2003). Although the methodology may have differed between these two

reports, this increased prevalence of obesity over time is nonetheless alarming. A recent report on the prevalence of obesity among Tricare beneficiaries in the military health care system indicated that approximately 13% of active duty military members have a BMI of 30 kg/m^2 or greater; National Quality Management Program, 2003). Collectively, these findings are similar to data from the 2005 DoD Survey of Health Related Behaviors, which revealed an increased prevalence in obesity in the Air Force from under 5% in 1995 to 12% in 2005 (Bray et al., 2006). Older (i.e., aged 40-65), African American, male military personnel have been found to be at greater risk of obesity than other soldiers (Pfizer Pharmaceuticals, 1999). This finding mirrors trends in the general U.S. population, where the prevalence of overweight and obesity tends to be higher among African Americans and older people compared with Caucasians and younger people, respectively (Ogden et al., 2006). Collectively, these reports suggest that the prevalence of overweight in the military is mirroring the rise of overweight in our nation.

The following sections of this literature review will provide and overview on 1) military weight and body composition standards, 2) problems associated with overweight in the military, 3) the role of environmental factors in overweight, and 4) the specific role of food proximity as an environmental factor in overweight. The review will conclude with a discussion of some individual factors that are important to consider when examining the association between environmental factors and overweight.

Military Weight and Body Composition Standards

Military service members were first perceived as becoming increasingly sendentary with a decline in overall fitness and an increasing tendency toward overweight and obesity shortly after the Vietnam War (Friedl & Vogel, 1997). In 1981, President

Jimmy Carter ordered a review of the fitness of military personnel, which led to the development of Department of Defense (DoD) Directive 1308.1. According to this directive, the purpose of maintaining weight and body composition standards in the military is to enhance “physical fitness, general health, and military appearance” (U.S. DoD, 1981). Each branch of service subsequently devised its own weight and fitness standards that were at least as stringent as the general guidelines set forth by this directive. Although the prevalence of overweight significantly decreased among soldiers within ten years of implementing this regulation, (Friedl & Vogel, 1997), many military personnel continue to struggle with meeting these standards today.

The proposed study will address obesogenic environmental factors among Air Force personnel stationed at Andrews AFB. Therefore, the Air Force weight and fitness standards will be described in detail.

Air Force Standards

Currently, the Air Force uses a composite fitness score from the annual physical readiness test (PRT) to determine one’s health and fitness level (Department of the Air Force, 2006). This score is comprised of aerobic fitness (i.e., timed 1.5-mile run – 50 points), muscular strength (i.e., timed sit-ups and push ups – 10 points each), and body composition (waist circumference – 30 points). Personnel with a BMI < 25 kg/m^2 automatically receive the full 30 points for body composition, regardless of their waist circumference. Waist circumference data is used to calculate the body composition score for personnel who have a BMI ≥ 25 kg/m^2. The rationale for including waist circumference as part of the fitness score was based on research that demonstrates that 1) distribution of body fat is a better indicator of health risk than mere presence of body fat

per se and 2) waist circumference is associated with cardiovascular risk factors independent of BMI (Baumgartner, 2003). The Air Force moved from cycle ergonometry testing to a timed run in 2004 because 1) it is a practical way of testing large numbers of people more often and more efficiently, 2) research that has demonstrated that running is also a valid measure of cardiorespiratory fitness (VO_2 max) and endurance, and 3) running may reducing risk of cardiovascular disease and cancer (Baumgartner, 2003). The sit-ups and push-ups are included as a measure of muscular strength, which is an important aspect of fitness per the American College of Sports Medicine guidelines (ACSM, 2007), as well as an important aspect of military readiness, as muscular strength can be an integral part of one's duties, particularly in operational settings (Baumgartner, 2003). A PRT score of 75 out of 100 possible points for a person's gender and age is considered a passing score. Personnel who obtain a failing score (< 75) and fail to show improvement over time may be subjected to administrative actions (e.g., receive letter of counseling after 90 days; ineligible for promotion, professional military education, or reenlistment after 6 months). After failing to show improvement after 12 months, personnel may be administratively separated (i.e., discharged) from the Air Force. According to DoD Survey of Health-Related Behaviors data, about 12% of the Air Force respondents reported failing their last PRT, and 4.3% of Air Force respondents reported being currently enrolled in the weight control program (Bray et al., 2006).

Consequences of Overweight in the Military

Health and Fitness

Aside from potentially negatively influencing one's career, overweight among military personnel has been associated with a number of consequences that could negatively impact mission readiness. In a study examining the assumptions underlying the Army's weight control program, Troumbley and colleagues found that overweight soldiers had greater health risk, lower health status, and lower physical fitness than normal weight soldiers (Troumbley, Rinke, Burman, & Lenz, 1990). Similarly, being overweight was a risk factor for injuries, and having a BMI of 30 kg/m^2 or greater was a risk factor for both injury and illness among cadets undergoing Basic Cadet Training at the Air Force Academy in 2002 (Billings, 2004). Bray et al. (2006) also reported that personnel who were diagnosed with overweight were 3x more likely to be diagnosed with a joint or back disorder in the previous year than normal weight personnel. Further, increased BMI is associated with Type 2 diabetes among military members, and the incidence of diabetes in the military is similar to rates in the civilian population despite military weight and fitness standards (Paris, Bedno, Krauss, Keep, & Rubertone, 2001). This latter finding suggests that military members are comparably vulnerable to comorbid health conditions associated with overweight in the general U.S. population (Flegal et al., 2002).

Recruitment and Retention

The increase in overweight in our nation makes recruitment in the military more difficult, particularly because applicants must meet the maximum allowable weight standards in order to be eligible to serve. The CDC administered the Third National

Health and Nutrition Examination Survey (NHANES III) to a nationally representative sample of 17-20 year-olds and found that 13-18% of men and 17-43% of women exceeded the military weight standards, with higher percentages among women and ethnic minorities (Nolte, Franckowiak, Crespo, & Andersen, 2002). Another study by Hsu and colleagues found that the prevalence of overweight and obesity among military applicants at their first MEPS encounter has increased from 22.8% and 2.8% respectively in 1993 to 27.1% and 6.8% respectively in 2006 (Hsu, Nevin, Tobler, & Rubertone, 2007). Therefore, many individuals who are overweight are either ineligible to join the military or must find a way to lose weight in order to attain eligibility. However, overweight is often a chronic, lifelong condition and overweight in childhood or adolescence has been shown to be predictive of overweight in adulthood (Field, Cook, & Gillman, 2005; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). The NHANES mobile examination center found that cardiorespiratory fitness level was lower among overweight than normal weight children and adolescents, and that 33% of 18-19 year-old men, and 41% of 18-19 year-old women did not meet cardiorespiratory fitness (i.e., VO_2 max) standards (Pate, Wang, Dowda, Farrell, & O'Neill, 2006). Considering that 80% of new recruits who exceed height and weight standards at entry are discharged before the end of their first enlistment (IOM, 2004), individuals who have a history of overweight prior to joining the military may have difficulty maintaining military weight and/or fitness standards without effective education, prevention, and intervention resources in place.

Economic Burden

In addition to negatively impacting health, fitness, mission readiness, recruitment, and retention, overweight is also a burden to the military healthcare system. The average annual inpatient cost for overweight-related diagnoses among military personnel was $5.8 million between 1993 and 1998, with each overweight-related inpatient event costing $4,030 annually across all ages (Bradham, South, Saunders, Heuser, Pane, & Dennis, 2001). Among active duty Air Force personnel in 1997, the estimated weight-attributable costs of overweight totaled $22.8 million (Robbins, Chao, Russ, & Fonseca, 2002) . Annual direct costs (i.e., increased medical care) were estimated to be $19.3 million, or 6% of annual active duty Air Force medical care expenditures. Estimated indirect costs (i.e., lost workdays) totaled $3.5 million, or 28,351 workdays per year. Further, a review of Army data of overweight-related problems from 1995 to 1997 revealed that approximately 40% of involuntary discharges from the Army were the result of being overweight (James, Folen, Garland et al., 1997). In summary, cost-effective prevention and intervention efforts are needed to help reduce both the health-related and economic burdens of overweight in the military.

The Role of Environmental Factors in Overweight and Obesity

The contribution of the environment to overweight has received increased attention in recent years. Although 25-40% of the variance in weight may be explained by genetics (Brownell & Horgen, 2004), there is growing agreement among researchers that the dramatic increase in the prevalence of overweight in the past few decades is primarily being driven by environmental factors as opposed to biological factors (Hill, Wyatt, Reed, & Peters, 2003). Egger and Swinburn (1997) conceptualize the

environmental influences on overweight arising from two sources: the macro-environment and the micro-environment. The macro-environment is defined as components of the environment at the national level (e.g., the food service industry and the physical fitness industry) that determine the prevalence of overweight in a population (Egger & Swinburn, 1997). The micro-environment is defined as components of the environment at a local level specific to an individual (e.g., food and physical fitness opportunities in one's home environment or work environment) that determines an individual's weight status (Egger & Swinburn, 1997). Although this study will primarily focus on the micro-environment, below is a brief review of some of the objective and perceived aspects of the macro-environment that may influence eating behavior and weight status at a population level. Given that the majority of work to date has been conducted in the civilian population, primarily civilian studies will be reviewed. However, military data will be reviewed when available.

An Overview of U.S. Food Environment Trends

U.S. Food Supply

The U.S. food supply (i.e., amount of food produced, including imports and excluding exports; Young & Nestle, 2002) has markedly increased in the past few decades. From the 1970s to the 1990s, overall energy availability per capita in the U.S. increased 15% (French, Story, & Jeffery, 2001; Young & Nestle, 2002), providing 500 kcal/d more per capita than it did in the 1970s (Young & Nestle, 2002). During this same time period, the availability of added fats and oils increased by 22% (Drewnowski & Specter, 2004; French, Story, & Jeffery, 2001). In contrast, availability of fruits and vegetables has increased 19% (French, Story, & Jeffery, 2001), although it should be

noted that potatoes (including French fries) are included in this figure. Between 1978 and 1993, the variety of candy, gum, snacks, and bakery foods increased sharply, while the variety of fruits, vegetables, and entrees increased at a much slower pace (Critser, 2003). Between 1942 and 2000, annual US production of carbonated beverages increased over 600% (Vartanian, Schwartz, & Brownell, 2007).

Portion Sizes

In general, away-from-home foods have larger portion sizes than foods consumed at home (French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001). Portion sizes are increasing in prepackaged products and at restaurants (Ledikwe, Ello-Martin, & Rolls, 2005; Young & Nestle, 2002). For example, Coca Cola, which was sold in 6.5 ounce bottles in 1916, is now commonly sold in 20-32 ounce bottles (French, Harnack, & Jeffery, 2000). Bagels have increased from 2-3 ounces to 4-7 ounces, and candy bars are sold in 3.7 ounce sizes as well as 1 ounce sizes (French et al., 2000). One study that compared the USDA standards of serving portions to commonly available foods and found that cookies exceeded USDA standards of portion size (i.e., weight) by 700%, and cooked pasta (480%), muffins (333%), steaks (224%), and bagels (195%) also exceeded these standards (Young & Nestle, 2002). Unfortunately, people tend to have a difficult time estimating an appropriate portion size as portion sizes increase (French et al., 2000). Laboratory research has repeatedly demonstrated that people tend to eat more when given larger portions of food (Ledikwe et al., 2005; Rolls, Morris, & Roe, 2002; Young & Nestle, 2002). For example, caloric intake was higher in both women (11%) and men (20%) when given a 12-inch submarine sandwich compared to when they were given an 8-inch sandwich (Ello-Martin, Roe, Meengs, Wall, & Rolls, 2002). Another study found

that macaroni and cheese intake was 30% greater when given a 1000g serving compared to a 500g serving, regardless of whether participants were served by another person or served themselves (Rolls et al., 2002).

Food Availability

Increased food production in the U.S. has led to increased food availability. In particular, access to high density, high fat foods has increased. Between 1972 and 1995, the prevalence of fast food restaurants increased 147% (French, Story, & Jeffery, 2001). In addition to fast food restaurants, the number of restaurants, bars, convenience stores, coffee shops, and vending machines have drastically increased in the past few decades (Booth, Pinkston, & Poston, 2005).

Military Food Availability

Similar to the civilian sector, where foods and drinks high in energy density and calories have increased in the community and schools (Anderson, Shapiro, Lundgren, Spataro, & Frye, 2002), the availability of fast food outlets on military installations is no exception, as many bases have several fast food outlets (Military Installation Guide, 2007). Given that fast foods and restaurant foods tend to be higher in fat, energy density, and portion size compared to foods from home, it is possible that the increased availability of these foods is affecting the consumption of these foods and weight status among military personnel, which is the overarching hypothesis of the proposed study.

The Toxic Environment: The Food Environment Default

The increased availability and variety of fast food, snacks, and soda has been associated with the increase in overweight (Drewnowski & Specter, 2004; Hill & Peters, 1998). States in the U.S. that had lower percentages of residents with a BMI $\geq$ 30 kg/m^2

had more residents per fast food restaurant than states that had higher percentages of residents with a BMI ≥ 30 kg/m^2 (Maddock, 2004). These increases in the food supply, portion size, and availability and their association with overweight and obesity has lead researchers to refer to our macro-environment as the “toxic environment” (Brownell, 2007). This “toxic environment” or “obesogenic environment” may limit the effectiveness of individual-level interventions (Egger & Swinburn, 1997). Historically, epidemics are controlled by modifying environmental factors (Egger & Swinburn, 1997). In order to effectively reduce the overweight and obesity epidemic, it is likely that environmental changes (e.g., modifying building design and regulating the food industry) may be necessary (Egger & Swinburn, 1997). However, any environmental changes should be informed by research that identifies environmental factors that contribute to overweight and obesity.

Environmental Defaults

Recently, at the Town Hall Forum on Obesity at the 2007 Society of Behavioral Medicine Conference (Brownell, 2007), Dr. Kelly Brownell described a phenomenon in which fewer people will take the time and energy to “opt in” to something (e.g., sign up for a pension plan when hired at a new job) as opposed to accepting the default (e.g., automatic enrollment in a pension plan upon being hired for a new job). In general, unhealthy foods are currently the default option in this nation, in that they are arguably more accessible, convenient, good-tasting, heavily promoted, and affordable than healthy foods (Brownell & Horgen, 2004; Wakefield, 2004). As a result, people’s eating habits tend to involve making more unhealthy food choices as opposed to healthy ones. In other words, it takes time and effort to “opt out” of unhealthy food options that have essentially

become the default in this country. Given the increased prevalence of fast food options on military installations, research is needed to examine the impact of this rising default option on eating behavior and BMI among military personnel.

Aside from the prevalence of energy dense and high fat foods, the environment also promotes physical inactivity. Technology has encouraged sedentary activities via the development of television, computers, and video games, as well as increased reliance on automobiles (Hill & Peters, 1998). Although military installations have free exercise facilities available to their personnel, technology has decreased the amount of manual labor conducted by military personnel in their daily work. This trend may contribute to the risk of overweight among military personnel, given strong evidence that physical activity can help offset the effect of poor eating habits on energy balance (Hill & Peters, 1998).

The Built Environment

The built environment may be defined as aspects of a person's surroundings that are made or modified by humans (vs. naturally occurring; Papas et al., 2007). The majority of studies to date examining the impact of the built environment on health behaviors have been in the area of physical activity. Aspects of the built environment that may promote physical activity and be protective against overweight include mixed land use (i.e., land that has multiple uses, including residential, business, and institutional uses), living in high-walkability neighborhoods (e.g., neighborhoods with sidewalks and crosswalks), living in compact counties (vs. sprawling counties), proximity to recreational outlets, and street connectivity (e.g., a street network with a grid pattern, which offers the most direct pathway between places; Ewing, Schmid, Killingsworth,

Zlot, & Raudenbush, 2003; Frank, Andresen, & Schmid, 2004; Leslie, Coffee, Frank, Owen, Bauman, & Hugo, 2007; Papas et al., 2007; Saelens, Sallis, Black, & Chen, 2003). The aspect of the built environment in the physical activity literature that is most relevant to the current study is proximity to recreational outlets, which is discussed below.

The Objective Micro-Environment: The Role of Proximity

Proximity to Recreational Outlets and Physical Activity

As one turns to the role of the micro-environment in overweight and obesity, research has shown that people are more likely to use nearby resources than resources that are farther away (Booth et al., 2005). For example, in a community sample of 413 Arlington, MA residents, Troped and colleagues found as both objective (i.e., GIS) distance and perceived distance from one's residence to a bike trail (i.e., the Minuteman Trail) increased, odds of reported bikeway use in the past four weeks decreased (Troped, Saunders, Pate, Reininger, Ureda, & Thompson, 2001). In a study examining exercise frequency among San Diego residents, people who lived in neighborhoods with a greater number of exercise facilities reported exercising more often than residents who lived in areas with fewer exercise facilities per capita, after adjusting for demographic factors (Sallis, Bauman, & Pratt, 1998). Similarly, in a study examining the number of exercise facilities per capita in each zip code for 2,692 women participating in the WISEWOMAN CDC program, an additional exercise facility per 1000 people was associated with lower BMI and lower risk of cardiovascular disease (Mobley, Root, Finkelstein, Khavjou, Farris, & Will, 2006). Another study of 1,803 healthy sedentary Australian individuals found an association between poor access to recreational facilities and overweight (Giles-

Corti et al., 2005). Taken together, these studies demonstrate an association between proximity to recreational outlets and BMI.

Proximity to Food Outlets and Weight

Compared to the physical activity environment, the food environment has received less attention regarding its influence on weight status (Papas et al., 2007). Proximity to food outlets in one's micro-environment (e.g., workplace, home) may influence food consumption (Papas et al., 2007). In a cross-sectional study of 10,763 men and women participating in the Atherosclerosis Risk in Communities Study, Morland and colleagues examined the association between presence of types of food stores in one's census tract and risk factors for cardiovascular disease (Morland, Diez Roux, & Wing, 2006). Morland et al. (2006) found that the presence of a supermarket in one's census tract was associated with lower rates of overweight, whereas the presence of convenience stores in one's census tract was associated with higher rates of overweight. However, they did not directly assess where participants shopped or types of food purchased, which would have strengthened the validity of their findings. In an earlier study using the same sample, Morland and colleagues examined the association between recommended intakes of food and nutrients using food frequency questionnaires and prevalence of supermarkets in one's census tract (Morland, Wing, & Diez Rouz, 2002). For each additional supermarket in one's census tract, fruit and vegetable intake increased 11% for Caucasians and 32% for African Americans (Morland et al., 2002). Once again, however, they did not assess where people shopped or types of food purchased.

In contrast, a study by Inagami and colleagues assessed where 2,620 Los Angeles residents shopped for groceries in relation to their home (Inagami, Cohen, Finch, & Asch, 2006). Using the distance between the centroids (i.e., geographic centers of one's home census tract and grocery store tract) to estimate the distance between one's home and the grocery store, the researchers found that individuals who traveled $\geq$ 1.76 miles to get to the grocery store had higher BMI had than individuals who shopped at a grocery store within their census tract (Inagami et al., 2006). Collectively, these findings suggest that access to a supermarket, which generally offer the more variety of healthy foods at a lower cost than smaller food stores (Inagami et al., 2006), may be protective against overweight, whereas the presence of convenience stores may increase risk of overweight.

In addition to convenience stores, access to fast food and other restaurants also may increase risk of overweight. Maddock (2004) used data from the Behavioral Risk Factor Surveillance System (BRFSS), the U.S. Census, and the U.S. Yellow Pages to examine the relationship between fast food outlet density and obesity rates. In a state-level analysis, a positive association was found between fast food restaurant density and prevalence of obesity (Maddock, 2004). More specifically, after controlling for gender, age, ethnicity, physical inactivity, fruit/vegetable intake, population density, and square miles per fast food restaurant and residents per restaurant accounted for 6% of the variance in obesity rates at the state level (Maddock, 2004). However, individual fast food consumption was not directly assessed. A study of 7,020 low-income children (ages 3-5) living in Cincinnati, OH did not find an association between proximity of fast food restaurants to home and risk of overweight (Burdette & Whitaker, 2004). However, preschoolers are highly dependent on their parents regarding food choices. Further, the

researchers only examined distance to the nearest fast food restaurant, which may not adequately capture overall proximity to fast food restaurants.

A telephone survey of 1,033 Minnesota residents examining the association between number of fast food and other restaurants within a two-mile radius of home and work and both eating behavior and BMI had mixed results (Jeffery, Baxter, McGuire, & Linde, 2006). Although they found a positive association between fast food restaurant use and high fat diet, low fruit-vegetable intake, and high BMI, the researchers did not find a relationship between restaurant proximity and BMI (Jeffery et al., 2006). They did, however, find a positive association between number of non-fast food restaurants within two miles of home and non-fast food restaurant use (Jeffery et al., 2006). It is important to note that the researchers did not adjust for physical activity or length of residence in their analysis, which may partially explain why they did not find an association between proximity to food outlets and BMI. Further, the authors noted that there was a large number of food outlets and limited variance in number of food outlets within two miles of home and work (i.e., the average number of restaurants of all types was 39 and 94 for home and work, respectively), which might imply crowding (Mobley et al., 2006) and may have contributed to the negative findings (Jeffery et al., 2006). The proposed study will examine the association between proximity to food outlets at Andrews AFB and BMI, and improve upon the methodology of the above studies by 1) directly assessing frequency of base food consumption, 2) assessing and controlling for length of residence (i.e., how long they have been stationed at Andrews AFB), and 3) select work buildings with high (15-17) vs. low (0-3) number of food outlets within 1 mile of where personnel work on base.

The Perceived Micro-Environment

Some research has found a disconnect between objective and perceived measures of the environment (Booth et al., 2005). Therefore, it is important to assess both objective and perceived aspects of the environment (McGinn, Evenson, Herring, Huston, & Rodriguez, 2007), which the present study will do. For example, some researchers propose that cost barriers to healthy eating may be more perceived than real (Drewnowski & Darmon, 2005). At this point, it is unclear whether the objective or perceived environment is more influential in eating behavior and physical activity (Brownson et al., 2004). Some researchers argue that people's perceptions of the environment may influence their behavior more than the objective environment itself (Davison & Lawson, 2006). Identifying the major source of influence is necessary in order to inform appropriate intervention efforts. If perceptions are more influential in eating behavior, educational efforts may be helpful in addressing perceptual barriers to healthy eating (Drewnowski & Darmon, 2005). However, if objective aspects of the environment are more influential, modifying the physical environment may be more appropriate. Below is a description of the elements of the perceived environment that may influence eating behavior and therefore will be examined in the current study.

Proximity

Some researchers propose that individuals may have difficulty perceiving distance or are biased in their perceptions of their environment based on their lifestyle and daily activities (Booth et al., 2005). For example, people may perceive some food outlets as "closer" than others because they are located near other places they go in their daily lives (e.g., food shopping, gas, military clothing, drycleaners) and/or they are in line with one's

preferences (e.g., in terms of taste, convenience, cost, nutritional value). Therefore, it is important to include a perceived measure in addition to an actual assessment of proximity to base food outlets when examining the influence of food proximity on eating behavior and BMI among military personnel.

Cost

Food prices also influence food purchasing behavior (Dehghan, Akhtar-Danesh, & Merchant, 2005; Drewnowski & Specter, 2004; Glanz, Basil, Maibach, Goldberg, & Snyder, 1998; Morland, Wing, & Diez Roux, 2002). Some research suggests that merely increasing availability of healthy foods may not be enough to increase their consumption (French, Story, Jeffery, Snyder, Eisenberg, Sidebottom, et al., 1997). In fact, decreasing prices of healthy foods consistently increase their consumption, whereas merely increasing the availability of healthy foods does not always increase their consumption (French et al., 1997). Aside from increasing healthy food consumption, decreasing prices of healthy food may decrease weight gain. One longitudinal study found a positive association between lower fruit and vegetable prices and lower increases in BMI over a three-year period (Papas et al., 2007). Unfortunately, the current environmental default in this nation is that unhealthy foods cost less than healthy foods (Brownell & Horgen, 2004; Wakefield, 2004), although some researchers argue that this statement is not always true (Drewnowski & Darmon, 2005). In general, energy dense foods tend to be cheap, which increases their sale (Drewnowski & Darmon, 2005). Economic analyses have revealed that the prices of sweets and fats increased at a lower rate than they did for fruits and vegetables between 1977 and 1997 (Drewnowski & Specter, 2004).

In summary, the financial environment (i.e., cost) may influence eating behavior and weight status among military personnel. Cost may include objective costs (e.g., cost of a typical meal at the Enlisted Club vs. fast food vs. dining hall) and perceived costs of food on base.

Convenience

Jaegar and Cardello (2007) propose that convenience is a multidimensional construct comprised of both time and effort. Convenience is an important factor that influences food choice, and lack of convenience may be a barrier to healthy eating habits (Drewnowski & Darmon, 2005; Drewnowski & Rolls, 2005; Glanz et al., 1998; Jaeger & Cardello, 2007). Convenient foods that take little preparation or waiting time (e.g., fast food, food in convenience stores or vending machines) are often high in energy density, which is associated with increased frequency and quantity of consumption (Drewnowski & Darmon, 2005). In one study, people with lower fruit and vegetable intake reported eating less of them because they are inconvenient (Glanz et al., 1998).

Jaegar & Cardello (2007) propose that convenience of foods may particularly influence whether or not military personnel eat or how much military personnel eat, given the presence of physical, psychological, temporal, and environmental stressors. They conducted a study manipulating time and effort associated with obtaining, preparing, consuming, and cleaning up after eating an MRE (i.e., meal-ready to eat) among enlisted and officer Army personnel during combat training exercises. Whereas standing in line (vs. sitting down) and preparing a cold beverage (vs. drinking water) were seen as more effortful, longer heating time and time spent cleaning one’s area were viewed as more time-consuming (Jaeger & Cardello, 2007). Considering that MREs are primarily eaten

on deployments or during training sessions, it is important to examine whether or not the perceived convenience of foods offered in garrison (e.g., cafeteria food, base club food, fast food) also influence eating behavior. Given the increased workload and decreased manpower due to deployments and the current war, convenience may impact food choices among military personnel.

Individual Factors Associated with Overweight and Obesity

In addition to environmental factors, a number of individual factors are associated with overweight and obesity. These individual factors include lifestyle factors, occupational factors, and demographic characteristics (CDC, 2007). When examining the influence of environmental factors on body mass index, it is important to assess other lifestyle factors that may influence weight (Astrup, 2005).

Lifestyle

A number of lifestyle factors have been shown to be associated with overweight and obesity, including eating habits, physical activity and exercise habits, sedentary activities, and smoking status. The lifestyle factors described below will be assessed in the current study.

Eating Habits

Unhealthy eating habits could simply be a marker for unhealthy lifestyle (Mela, 2001), so it is important to assess and adjust for other lifestyle factors that may influence weight as necessary (Astrup, 2005). One study found that having a healthy lifestyle was associated with placing a higher importance on nutritional value when making food choices (Glanz et al., 1998). However, lifestyle did not predict consumption of fast food

(Glanz et al., 1998). Therefore, it is important to assess both base food intake and other lifestyle factors.

Frequency of eating out. Americans are eating out more than they have in the past. People are 40% more likely to eat at restaurants at least 3 times per week than they were twenty years ago (Ledikwe et al., 2005). Multiple studies have shown that frequency of eating out is positively associated with higher fat intake, lower fruit and vegetable intake, and risk of overweight and obesity (Binkley, Eales, & Jekanowski, 2000; Bowman & Vinyard, 2004; French et al., 2000; McCrory, Fuss, Hays, Vinken, Greenberg, & Roberts, 1999; Pereira et al., 2005). From 1977 to 1995, percentage of fast food meals and snacks has increased 200% and non-fast food restaurant use has increased 150% (French et al., 2001). Little is known about the frequency of eating out among military personnel; it will be assessed in the current study. Because many military personnel live off base and could have very different residential food environments and eating habits, this study will assess eating out habits both on and off base.

Frequency of eating out and demographic factors. Research has shown that the frequency in which people eat out, particularly at fast food restaurants, differs by demographic groups. More specifically, people who are younger, non-Caucasian, lower-SES, and men, report eating fast food more frequently than older, Caucasian, higher SES, and women, respectively (French et al., 2000; Jeffery et al., 2006; Pereira et al., 2005). Given that the large proportion of fast food outlets on base, the current study will control for demographic factors when examining the relationship between food proximity and frequency of base food consumption.

Frequency of eating out and quality of diet. Fast food is associated with a diet high in energy density and low in macronutrients (Kipke, Iverson, Moore et al., 2007). Fast food may be defined as “food purchased in self-service or carry-out eating places without waiter service” (French, et al., 2001). It is important to note, however, that the definition of fast food tends to differ across studies. Consumption of foods high in energy density and poor in macronutrients is associated with decreased odds of eating foods from all five food groups and meeting daily recommended allowances (Kant, 2000). A three-year prospective study of 891 women (ages 20-45) revealed that frequency of fast food consumption is positively associated with energy intake, fat intake, and percent fat in a dose response pattern (French et al., 2000). Additionally, higher frequency of fast food consumption was associated with lower fruit, vegetable, grain, and milk intake (French et al., 2000). Another study using an interviewer-administered 24-hour dietary recall found that frequency of fast food consumption (i.e., fast food places and pizza places) was positively associated with energy and fat intake (Bowman & Vinyard, 2004). In general, away-from-home foods are higher in fat, energy, sugar, and salt compared to foods eaten at home (Drewnowski & Darmon, 2005; French et al., 2001).

Frequency of eating out and body weight. The literature is mixed regarding the influence of frequency of eating out and body weight. One 15-year prospective study of 3,031 young African American and Caucasian adults (ages 18-30) found a strong positive association between frequency of fast food consumption and increases in body weight and insulin resistance after adjustment for other lifestyle factors, including physical activity and television viewing time (Pereira et al., 2005). A three-year prospective,

observational study of 891 women in the Pound of Prevention weight loss study found that frequency of fast food consumption was associated with body weight, and women who reported an increase in fast food intake in the three-year period gained 43% more weight than women who did not report an increase in fast food intake (French et al., 2000). However, an association between frequency of fast food consumption and obesity was only found among men in this sample (French et al., 2000).

A three-year prospective study of 3,394 participants in the Coronary Artery Risk Development in Young Adults study found a positive association between fast food consumption and BMI (Duffey, Gordon-Larsen, Jacobs, Williams, & Popkin, 2007). The researchers also found that increased consumption of fast food or both fast food and regular restaurant food were associated with increased BMI three years later (Duffey et al., 2007). However, Duffey and colleagues (2007) did not find an association between increased regular restaurant food consumption (i.e., excluding fast food consumption) and BMI.

A study using an interviewer-administered 24-hour dietary recall on two different days found a positive association between frequency of fast food and pizza consumption and overweight status (Bowman & Vinyard, 2004). Similarly, a study examining the source of foods and overweight found that both men and women were likely to weigh more if they consumed foods away from home (particularly fast foods) than if they did not consume foods from away from home (Binkley, Eales, & Jekanowski, 2000). Another study of adults ages 19-80 with a BMI of 18-33 found an association between frequency of restaurant food consumption in one month (i.e., "fried chicken, burger, pizza, Chinese, Mexican, fried fish, and 'other'" in the past month using a food frequency

questionnaire) and body fatness (McCrory et al., 1999). The analyses adjusted for age and sex, and the relationship strengthened when controlling for physical activity. Several longitudinal studies have found a positive association between soft drink consumption and weight gain (Vartanian et al., 2007).

One study did not find a relation between energy-dense, nutrient poor intake and odds of overweight status or high waist circumference (Kant, 2000). However, this study only assessed one day's worth of food intake, which may not have been representative of the participants' overall diets.

Taken collectively, it appears that there is a positive relation between frequency of eating out and BMI. However, it is possible that the discrepancies in the literature may be due to 1) the source of the food (e.g., fast food restaurant vs. sit-down restaurant), 2) not accounting for overall diet quality (which may or may not be healthier compared to eating out, depending on the individual), or both. This study will assess where foods are obtained as well as account for diet quality when examining the relationship between eating food from base food outlets and BMI among military personnel.

Energy intake. In a review of determinants of energy intake, Prentice and Jebb (2003) suggest that energy density of foods largely determines energy intake. Foods that are higher in energy density have low satiety power (Drewnowski & Darmon, 2005). Further, humans have a difficult time identifying foods with high energy density, which leads to "passive over-consumption" as a result of failure to appropriately down-regulate the amount of food consumed (Prentice & Jebb, 2003). Therefore, foods eaten outside of the home may result in differences in both the quality and quantity of foods consumed. In support of this hypothesis, one study found that frequency of restaurant food

consumption was positively associated with energy intake (*r* = .59) and fat intake (r = .28), and negatively associated with fiber intake (r = -.45; McCrory et al., 1999). A meta-analysis found evidence that people do not reduce their food intake to compensate for the amount of energy consumed by soft drinks (particularly sugar-sweetened soft drinks); in fact, their food intake may be even higher (Vartanian et al., 2007). Additionally, negative associations were found between soft drink consumption and milk, dairy, fiber, protein, fruit juice, fruit, and starch intake in a number of cross-sectional, longitudinal, and experimental studies (Vartanian et al., 2007). In a study examining energy intake among 54 adolescents ages 13-17 who ate a fast food meal in a food court, Ebbeling and colleagues found that all adolescents overate regardless of weight status, with energy intake averaging 1652 kcal, or approximately 61.6% of daily energy requirements (Ebbeling, Sinclair, Pereira, Garcia-Lago, Feldman, & Ludwig, 2004). However, overweight adolescents were less likely than lean adolescents to compensate for the extra calories consumed on a fast food day, suggesting a potential mechanism underlying the relationship between fast food consumption and weight status (Ebbeling et al., 2004). Although energy intake will not be assessed in the current study, it is important to note that "passive over-consumption" may be a potential mechanism for the relation between frequency of eating out and BMI.

Dietary fat intake. In addition to excess energy intake, excess dietary fat intake also has been positively associated with obesity. In animal models, animals who are given high-fat diets ($\geq$ 35% of their dietary intake from fat) have been shown to have greater energy intake, greater percent body fat, and greater weight gain than animals who are given a low-fat diet with similar activity levels (Hill & Peters, 1998). Among

humans, approximately 40% of the average American diet consists of fat and sugar intake (Drewnowski & Darmon, 2005). Research has found that obese individuals tend to overconsume fat (Drewnowski, 1997). When excess energy comes from fat rather than carbohydrates or protein, body fat storage occurs at a faster rate (Hill & Peters, 1998). A review of 28 weight loss clinical trials revealed that a 10% reduction in fat intake relative to other macronutrient intake was associated with a 16g/d weight loss (Bray & Popkin, 1998). However, it is important to note that although fat intake has begun to decrease among Americans, the rates of obesity have only increased (Bray & Popkin, 1998; Hill & Peters, 1998). Some researchers argue that this trend may in fact the result of underreporting fat consumption (Bray & Popkin, 1998; Hill & Peters, 1998). Alternatively, other research indicates that although the percent of energy intake from fat has decreased between 1970 (42%) and 1994 (38%), the absolute value of grams of fat available has increased 3% during that time (French et al., 2001). However, not all researchers belive that dietary fat intake leads to obesity (Hill & Peters, 1998). However, overall diet quality (which includes fat intake) will be assessed in the current study when examining the relation between frequency of eating out and BMI.

Snacking. According to several USDA surveys, young adult (ages 19-29) snack consumption has increased from the 1970s to the 1990s (Zizza, Siega-Riz, & Popkin, 2001). Percentage of non-snackers has decreased, and snacking was associated with higher intakes of carbohydrates, fat, and saturated fat (Zizza et al., 2001). During this time, the number of daily snacks increased 14%, the proportion of total daily energy from snacks has increased from 20% to 23%, and energy intake from a snack has increased by 26% (Zizza et al., 2001). Further, research has demonstrated that snacking does not

affect subsequent meal intake (Marmonier, Chapelot, & Louis-Sylvestre, 2002), which may be a potential mechanism for the relationship between snacking and increased energy intake. Given these findings and the large number of young adults in the military, this study will include both meals and snacks when assessing frequency of base food consumption.

Dieting status. Lowe and colleagues have proposed three subtypes of dieting: current dieting (i.e., people who are currently dieting in order to lose weight), former dieting (i.e., people who have dieted to lose weight in the past but who are not currently dieting), and weight suppression (i.e., significant diet-induced weight loss, operationalized as the discrepancy between a person's highest weight and current weight; (Lowe, 1993). The current dieting subtype will be assessed in the proposed study. Current dieting status may affect eating behavior (Mela, 2001). According to one study, 24% of Navy hospital personnel reported going on a strict diet in preparation for an upcoming physical fitness test, and 18% reported losing $\geq$ 10 pounds in preparation for the PRT (Carlton, Manos, & Van Slyke, 2005). Aside from increasing exercise and decreasing caloric intake (i.e., the definition of dieting above), a number of studies have shown that some military men and women engage in extreme weight control behaviors (e.g., use of laxatives, diuretics, diet pills, fasting, meal skipping) in order to lose weight, particularly prior to weigh-ins (Carlton et al., 2005; Lauder & Campbell, 2001; Lauder, Williams, Campbell, Davis, & Sherman, 1999; McNulty, 1997a, 1997b, 2001; Seibert, Sbrocco, Hsiao, & Lewis, submitted for publication). Even though a number of studies have shown that dieting leads to weight gain (Lowe et al., 2006), the military studies described above suggest that military personnel may be effective at losing weight in the

short-term, particularly in preparation for the PRT. Therefore, it is important to assess current dieting status when examining the influence of environmental factors on BMI among military personnel.

Physical Activity and Exercise

Numerous studies have found a strong association between physical inactivity and obesity (Hill & Peters, 1998; Lopez-Zetina, Lee, & Friis, 2006). Compared to sitting, walking doubles energy expenditure (French et al., 2000). One study found each kilometer walked was associated with a 4.8% reduced odds of obesity after adjusting for age, income, and education level (Frank et al., 2004). Research has shown that people are less likely than they used to be to walk or bike for transportation (French et al., 2000).

Generally, epidemiological surveys and state health survey data from BRFSS have found little change in rates of physical activity during the past few decades, suggesting that increases in overweight and obesity rates at the population level may be due more to increased energy intake rather than decreased energy expenditure (French et al., 2000). Nonetheless, it is important to adjust for individual physical activity levels when examining the role of environmental factors in BMI, as individual physical activity level may influence an individual’s risk for overweight or obesity.

In the military, the degree to which units monitor their personnel’s exercise levels varies. Units may 1) expect personnel to exercise on their own time outside of duty hours, 2) require personnel to exercise as a unit, or 3) grant certain amount of time per week to exercise during duty hours. It is not known how these differences may impact exercise frequency among military personnel. However, given the association between exercise and body weight/composition, exercise frequency, intensity, and duration (in

METs) will be adjusted for when examining the relationship between frequency of base food consumption and BMI.

Sedentary Activities

Although few changes have been noted in physical activity and exercise habits in the past few decades (French et al., 2000), sedentary activity has increased over the years. Individuals who spend more time engaged in sedentary activities (e.g., watching television, working on the computer, commuting to work) are more likely to be overweight than individuals who spend less time engaged in these sedentary activities (Brownell & Horgen, 2004; Frank et al., 2004). For example, weekly television viewing time increased 44%, or from 10.4 hours to 15.1 hours, between 1965 and 1985, respectively (French et al., 2000). The average adult spends two hours per day watching television, and approximately 53% report that they usually snack when watching TV (French et al., 2000). One study found that the highest mean rank of obesity was associated with highest rank of miles of vehicle travel (Lopez-Zetina et al., 2006). The number of daily household vehicle miles traveled increased 29% between 1983 and 1990 (French et al., 2000). Another study found that each additional hour spent in a vehicle was associated with a 6% increased odds of obesity after adjusting for age, income, and education level (Frank et al., 2004); however, the odds ratio was small and the confidence interval hovered around 1.0 (*OR* = 1.001, CI = 1.001-1.002). Given the wide range of commute times in the Washington, DC area due to traffic, commute times will be assessed in the current study and examined in relation to BMI.

Smoking Status

Research has found an inverse relationship between smoking and BMI. As smoking behavior increases, resting metabolic rate increases and BMI decreases (Ewing, Brownson, & Berrigan, 2006; Mobley et al., 2006). Given this inverse relationship, and given the high rates of cigarette smoking (33.8% reported smoking at least one cigarette in the past 30 days) and smokeless tobacco use (17.1%) among military personnel (Bray et al., 2006), this study will assess smoking status and examine its relationship with BMI.

Occupational Factors

Several occupational factors may influence one's eating habits, and therefore be associated with overweight and obesity. These factors, including military specific factors, may include work hours, perceived stress, job type (i.e., operational vs. support), travel (e.g., temporary duty (TDY) or deployment), and the PRT cycle.

Work Hours

Personnel who work longer work hours may have less time for engaging in recreational activities, including exercise, which could affect one's weight status. Time demands at work also may increase the likelihood of consuming food that is quick and convenient (e.g., fast food, food from vending machines), which may be higher in calories, fat, and portion size than freshly prepared foods (Prentice & Jebb, 2003). One study involving female office workers found that workers reported higher energy intake and higher percent fat intake during high workload periods compared with normal workload periods (McCann, Warnick, & Knopp, 1990). Another study comparing food intake between periods of regular workload (average of 32 hours in the past seven days) and high workload (average of 47 hours in the past seven days) of staff in a department

store in London found that energy, fat, and sugar intake was higher during high workload periods compared to regular workload periods within individuals (Wardle, Steptoe, Oliver, & Lipsey, 2000). Given that military personnel may have high workload periods at the time of assessment, the number of hours worked in the last seven days will be assessed in the current study and used as a covariate when examining the relationship between food proximity and frequency of base food consumption.

Perceived Stress

According to data from the 2002 Survey of Health Related Behaviors, 84.9% of active duty Air Force personnel reported experiencing “a lot” (26.3%), “some” (31.8%), or “a little” (26.8) stress in the past 12 months (Bray et al., 2003). Sources of stress among all active duty personnel included being away from family (19.1%), deployment (19.1%), increases in workload (15.0%), and changes in personal life (15.0%; Bray et al., 2003). In order to cope with stress, 41.4% of Air Force personnel reported getting something to eat and 63.8% reported exercising or playing sports (Bray et al., 2003).

Although some civilian research has shown that stress influences eating behavior and has been positively associated with overweight (van Lenthe & Mackenbach, 2002), the type and amount of food eaten in response to stress may differ depending on the individual and the nature (e.g., length, severity) of the stressor (Oliver & Wardle, 1999; Torres & Nowson, 2007). In one study, 42% of 212 college students reported eating more while under stress, and 38% reported eating less under stress (Oliver & Wardle, 1999). Although no gender difference in reported overall intake was found, women were more likely to report eating more sweets and chocolate than men (Oliver & Wardle, 1999). Similarly, some laboratory studies have found a gender difference in types of

food eaten under stress. Zellner and colleagues conducted two studies (one with men and one with women) in which college students were randomly assigned to either a stress or no-stress condition (i.e., given unsolvable vs. solvable 5-letter anagrams, respectively; Zellner, Loaiza, Gonzalez, et al., 2006; Zellner, Saito, & Gonzalez, 2007). The researchers found that women in the no-stress condition ate more grapes whereas the women in the stress condition ate more chocolate (Zellner et al., 2006). In contrast, the men in the no-stress condition ate more chips and chocolate than men in the stress condition (Zellner et al., 2007), which was contrary to what they reported that they do under stress.

However, not all laboratory studies find gender differences. Oliver and colleagues examined the influence of stress (i.e., preparing to give a four-minute speech after eating a meal) on eating behavior compared to a no-stress control condition in which participants listened to a neutral text (Oliver, Wardle, & Gibson, 2000). Although stress did not alter overall energy intake, but people in the stressed condition ate more sweet foods high in fat and energy density, and no gender x stress interaction was found (Oliver et al., 2000). Given the high prevalence of high-fat, energy dense foods on military installations and the high percentage of Air Force personnel who report getting something to eat to cope with stress, this study will examine the association between perceived stress and eating behavior and adjust for this factor if necessary when examining the relationship between food proximity and frequency of base food consumption.

Job Type

Given that walking burns twice as many calories as sitting (French et al., 2000), it is possible that personnel who work in jobs that are more sedentary in nature (e.g.,

administrative personnel, desk jobs) may have a lower daily energy expenditure than personnel who work in jobs that are more active (e.g., mechanics, operational jobs). Therefore, differences in BMI by job type will be described in the current study. IPAQ scores, which include work-related physical activity, will assist in adjusting for differences in BMI that may be due to occupation. Further, efforts were made to ensure that the two proximity groups are comparable in terms of job type (i.e., proportion of desk job vs. manual labor job participants in each group) when recruiting units for study participation.

Temporary Duty and Deployment

Food availability may differ when working away from one's current duty station through temporary duty (TDY) or deployment. For example, meals-ready-to-eat (MREs) are often consumed on deployment, and personnel may eat more fast food when they are traveling. Differential availability to exercise facilities during these times also may affect one's physical activity level. Hence, TDY and deployment may affect one's weight and/or body composition over time. Therefore, this study will assess personnel's frequency/time spent away from their stateside duty station.

Physical Readiness Testing Period

Research has shown that weight among military personnel is affected by PRT periods. One study found that 18% of a sample of active duty Navy personnel assigned to the Portsmouth Medical Center reported losing at least 10 pounds prior to a weigh-in/PRT (Carlton et al., 2005). This study will assess whether or not the date of the individual's last PRT or next PRT is related to BMI.

Demographic Factors

Gender, Age, and Race/Ethnicity

The prevalence of overweight and obesity differs by individual characteristics. Also, the importance of taste, cost, convenience, and nutrition when making food choices appears to differ by demographic factors (Glanz et al., 1998). According to data from the 2003-2004 National Health and Nutrition Examination Survey, men (70.8%) are more likely to be overweight or obese than women (61.8%; Ogden et al., 2006), and other studies have supported that trend (van Lenthe & Mackenbach, 2002). Overweight status is more prevalent among non-Hispanic African Americans (76.1%) and Mexican Americans (75.8%) than non-Hispanic Caucasians (64.2%; Ogden et al., 2006). Whereas obesity rates do not differ by race/ethnicity among men, Mexican American women (42.3%) and non-Hispanic African American women (53.9%) are more likely to be obese than non-Hispanic Caucasian women (30.2%; Ogden et al., 2006). In one study, Asian women had a 4.07 kg/m^2 lower average BMI than Caucasian women (Mobley et al., 2006). BMI and odds of overweight have been shown to increase with age (Ewing et al., 2006; van Lenthe & Mackenbach, 2002). One study found that each year increase in age was associated with a 0.04 kg/m^2 in BMI and a 8.5% increase risk of cardiovascular heart disease (Mobley et al., 2006). Obesity is more common among older adults (36.8% of people ages 40 - 59) than younger adults (28.5% of people ages 20 – 39; Ogden et al., 2006). In the CARDIA study of subjects ages 20-40, the average weight gain per year was 1.8 to 2.0 pounds, which translates into an average excess in caloric intake of 50 kcal per day (Hill et al., 2003).

The demographic patterns of overweight and obesity rates among military personnel are similar to patterns found in the general U.S. population. According to the 2002 Survey of Health Related Behaviors for active duty military personnel: 1) active duty men are at greater odds of being overweight than active duty women, 2) personnel ages 35 and older have greater odds of being overweight than younger personnel, and 3) non-Hispanic African Americans and Hispanics are more likely to be overweight than non-Hispanic Caucasian military personnel (Bray et al., 2006). In terms of obesity, older (i.e., aged 40-65), African American, male military members are at greater risk of obesity than other military personnel (Pfizer Pharmaceuticals, 1999). Given that BMI differs by sex, age, and race/ethnicity among both civilians and military personnel, these factors will be assessed and adjusted for in the data analyses.

Income/Rank

In the U.S., people with a lower income are more likely to be overweight and obese than people with a higher income (Drewnowski & Darmon, 2005; Townsend, 2006). However, a study of children ages 2-19 using 1999-2004 data from NHANES suggests that the relationship between income and overweight may differ by race/ethnicity (Freedman, Ogden, Flegal, Kahn, Serdula, & Dietz, 2007). Overweight was negatively associated with income for Caucasian and Mexican American children, whereas overweight was positively associated with income for African American children (Freedman et al., 2007). Although quantity of food consumed may not differ by income, low-income families tend to consume foods that are high in energy density and low in cost, which may be in part due to differential availability (Drewnowski & Darmon, 2005; French et al., 2000). In the military, rank may be considered a proxy for income.

Similar to civilian research findings, enlisted military personnel (i.e., lower ranking personnel who make less money) are more likely to be overweight than military officers (i.e., higher ranking personnel who make more money; Bray et al., 2006).

Education Level

Research has shown that overweight and obesity are more common among less educated individuals compared to individuals with some college education (Drewnowski & Darmon, 2005; van Lenthe & Mackenbach, 2002; Zhang & Wang, 2004). One study did not find an association between education and BMI; however, they did find a negative association between cardiovascular heart disease risk and education level (Mobley et al., 2006). In contrast, military personnel who have more formal education have a greater risk of being overweight than personnel with a high school education or less (Bray et al., 2006). Perhaps this finding may be in part a result of people with a higher education level being more likely to be officers or work in more administrative or sedentary jobs and consequently burn fewer calories in their daily work than people with a lower education level, who may work in jobs involving more manual labor and burn more calories in the course of their daily work. More research is needed to examine the reasons for this pattern. Education level will be assessed in the current study in relation to BMI.

Marital Status

In the civilian sector, married adults are generally healthier than unmarried adults (Shoenborn, 2004). However, one study found that married adults, particularly men, had higher overweight and obesity rates than unmarried adults across race, ethnicity, education, poverty status, and nativity status (Schoenborn, 2004). Adults who had never

been married were much less likely to be overweight or obese (Schoenborn, 2004). These findings are supported in military research, as personnel who are married and have a spouse present have greater odds of being overweight than personnel who are not married (Bray et al., 2006). Therefore, marital status will be assessed in the current study in relation to BMI.

Summary and Rationale for Current Study

Over half of active duty military personnel are either overweight or obese. Whereas much research to date has examined individual factors associated with overweight (e.g., diet, exercise, and demographic factors), the role of environmental factors has received less attention. The purpose of the proposed study was to examine the association between objective and perceived aspects of a military base food environment and both eating behavior and body mass index among Air Force personnel. Research examining the direct relationship between the built environment and obesity in the civilian sector has largely been inconclusive, perhaps because the relationship is in fact an indirect one (Rutt & Coleman, 2005). To address the possibility of an indirect association, the proposed study directly assessed frequency of base food consumption and examining its association with workplace proximity to base food outlets, BMI, and PRT score. By focusing on a military population, the study findings and suggestions for modifying the base food environment can be shared with base leadership, who in turn may work with AAFES on base in order to impact the base food environment more quickly than is feasible in the civilian sector. Additionally, it is hoped that the results of this study will help inform prevention and intervention efforts for overweight among

military personnel and supplement the individual weight management efforts already in place.

Specific Aims

This study had two aims. First, to examine the association between physical access to food and eating behavior, BMI, and PRT score. Second, to examine the association between perceived access to food and eating behavior. See Figure 1 for the model that pertains to the hypotheses tested in the current study.

Hypotheses and Data Analytic Strategy

Aim 1: Easier physical access to food will be associated with greater frequency of food consumption, higher BMI, and lower PRT score.

Hypothesis 1a. Workplace proximity to base food outlets will be positively associated with base food consumption frequency.

Proximity to base food outlets will be operationalized as the average distance from one's work building to base food outlets. Frequency of base food consumption will be compared in personnel who work in buildings with different average proximity to food outlets (i.e., < 1 mile and > 2 miles). A hierarchical multiple regression correlation analysis (MRC) will be used to test this hypothesis. Workplace proximity will be the predictor variable and frequency of base food consumption will be the outcome variable. Covariates that are significantly associated with base food consumption will be entered into the equation in the first step (e.g., gender, age, work hours), and categorical covariates will be dummy coded. The predictor variable (i.e., proximity to base food outlets) will be dummy coded and entered in the second step.

Other factors associated with frequency of base food consumption. The association between base food consumption and the following factors also will be examined: place of residence (i.e., dormitory, base housing, or off-base) and weather.

Hypothesis 1b. Workplace proximity to base food outlets will be positively associated with BMI.

This hypothesis will be tested using a hierarchical multiple regression correlation analysis (MRC). BMI will be the outcome variable, and frequency of base food consumption will be the predictor variable. Covariates that are significantly associated with BMI will be entered into the equation in the first step (e.g., activity, demographic factors). Categorical variables will be dummy coded. The predictor of interest (i.e., frequency of base food consumption) will be entered in the second step.

Exploratory moderation analysis. The hierarchical MRC analysis will be run again with moderators of interest (gender, race/ethnicity, and physical activity) entered in the third block.

Other factors associated with BMI. The association between BMI and the following factors also will be examined: dieting status, smoking status, education level, and marital status. Based on findings in military and civilian literature, it is hypothesized that current dieting, current smoking, and education level will be negatively associated with BMI. It is hypothesized that being married will be positively associated with BMI. Point-biserial correlations will be used to assess the association between BMI and dichotomous factors (i.e., dieting status, smoking status, and marital status (i.e., married vs. not married). A Kruskal-Wallis test will be used to examine the association between

education level and BMI. Associations between BMI and the following factors also will be examined: TDY/deployment, job type, duty status, PRT cycle, and commute time.

Hypothesis 1c. Workplace proximity to base food outlets will be negatively associated with PRT score.

This hypothesis will be tested using MRC. PRT score will be the outcome variable and base food consumption frequency will be the predictor variable. Covariates significantly associated with PRT score will be entered in the first block (e.g., BMI, commute time, marital status). The predictor of interest (workplace proximity to base food outlets) will be entered in the second block.

Hypothesis 1d. Frequency of base food consumption will be positively associated with BMI.

This hypothesis will be tested using MRC. BMI will be the outcome variable. Covariates will be entered into the equation in the first step (e.g., physical activity, gender, age, race/ethnicity). Categorical variables will be dummy coded. The predictor of interest (i.e., frequency of base food consumption) will be entered in the second step.

Exploratory moderation analysis. Similar to the moderation analysis for H1b, moderation effects of gender and race/ethnicity on the relation between base food consumption frequency will be examined by entering the interaction terms in the third block.

Hypothesis 1e. Frequency of base food consumption will be negatively associated with PRT score.

This hypothesis will be tested using MRC. PRT score will be the outcome variable. Covariates significantly associated with PRT (e.g., BMI, commute time, marital

status) will be entered in the first block. The predictor of interest (i.e., base food consumption frequency) will be entered in the second block.

Aim 2: Greater perceived access to food will be associated with a greater frequency of food consumption.

Hypothesis 2a. Perceived proximity to base food outlets will be positively associated with frequency of base food consumption.

Hypothesis 2b. Perceived cost of food at base food outlets will be negatively associated with frequency of base food consumption.

Hypothesis 2c. Perceived convenience of base food outlets will be positively associated with frequency of base food consumption.

Perception of base food outlets and base food (i.e., proximity, cost, convenience) will be assessed using 6-point Likert scales (see Appendix C). Spearman correlations will be used to test the hypotheses 2a-2c.

Hypothesis 2d. Objective food proximity will be positively associated with perceived food proximity.

The association between objective and perceived food proximity will be tested using a point-biserial correlation, with objective food proximity as the dichotomous factor and perceived food proximity as the continuous factor.

II. RESEARCH DESIGN AND METHODS

Overview

Primary variables assessed were self-reported eating behavior (i.e., frequency of base food consumption), self-report PRT score, and measured BMI. Participants were assessed in groups within their units, with study procedures lasting approximately 30-45

minutes. During that time, participants completed a survey and had their height and weight formally measured.

This study was a single factor, cross-sectional design. The primary predictor variable was measured proximity of workplace to base food outlets. The primary outcome variables were frequency of base food consumption and BMI.

Participants

Participants were recruited from Andrews Air Force Base, MD. Andrews AFB has approximately 7,700 active duty Air Force personnel (Andrews AFB, 2007; Military Installation Guide, 2007). The mission of the base is to provide airlift, logistics, and communication support for US senior leaders, as well as maintaining airlift and response capabilities for national security and deploying forces (Andrews AFB, 2007). In addition to communication and logistics groups, the base also has medical, operations, and support groups (Andrews AFB, 2007).

Study participants were 192 Air Force personnel (i.e., active duty or full-time reserve or guard) stationed at Andrews Air Force Base, MD. The only exclusion criterion was personnel who were currently on a medical waiver that interferes with one's ability to exercise, which could affect BMI. Seven people (6 male, 1 female) reported they were on a medical waiver during the informed consent process and were excluded from participation at that time.

Recruitment

The principal investigator (PI) e-mailed a brief written description of the background, methods, and importance of the study to an Air Force Public Affairs Officer (see Appendix A). The Public Affairs Officer and PI provided the study information to

11 unit commanders, asking them for permission to assess personnel in their unit who are interested in participating. Participants were recruited from work buildings with close average distances to base food outlets (i.e., < 1600 meters or < 1 mile) and far average distance to base food outlets (i.e., > 3200 meters or > 2 miles). Participants were recruited through study advertisements containing the date(s), time(s), and location(s) for study participation, as well as the PI's phone number (see Appendix B for sample study advertisements). Unit POCs assisted the principal investigator in coordinating the time and location for each assessment. Efforts were made to ensure that the two proximity groups are comparable by job type in order to make the groups comparable with regard to work-related factors. Ten out of 11 units invited to participate had personnel who volunteered to participate. Compared to the Andrews AFB population as a whole, the study sample had a greater percentage of civil engineering personnel (18% vs. 12.4%) and maintenance (6.8% vs. 2.9%) personnel and a smaller percentage of security forces personnel (20.0% vs. 24.4%; P2R2, 2007). The sample was representative of Andrews AFB in terms of percentage of Mission Support, Services, Communications, and Logistics/Readiness occupational areas (P2R2, 2007).

Procedures

Participants from each unit were assessed in groups of approximately 10-30 participants. In order to prevent coercion, separate assessments were scheduled for 1) unit personnel ranks E1-E6 (who are not NCOICs) and 2) unit leadership (NCOICs and ranks E7 and above, including officers). The PI introduced herself and the research assistants by their first and last names (no rank in order to prevent coercion). All members of the research team wore civilian clothing and called one another by their first

names (no rank) at all times in order to prevent coercion. The PI then described the purpose of the study and reviewed the consent form with the participants. The survey was only administered to those personnel who chose to participate and signed and returned the consent form. The survey took approximately 15-20 minutes to complete (see Appendix C).

Participants also underwent a height and weight assessment with their shoes removed. Their height and weight were recorded on a separate form along with corresponding survey number on the front cover of the survey (see Appendix D). In order to decrease participant burden, approximately half of the participants in each group had their weight and height assessed prior to filling out the survey and half of the participants had their weight and height assessed after completing the survey. Participants were randomized to the order of study procedures as they walked into the room using a random number table (odd vs. even numbers), with the order noted in the upper right hand corner of each participant's consent form (i.e., odd numbers = 1 = survey first; even numbers = 2 = weight/height first). The participant was not informed of his or her order of study procedures until after informed consent was obtained. The order of the procedure for each participant was recorded on the height/weight form in order to permit including a variable for order of study procedures as a covariate in the analysis if needed. In order to protect participant anonymity, the participants' names did not appear anywhere on the survey and were not recorded during the height and weight assessment. The consent forms have been stored separately from the surveys and they are not linked to one another in any way.

Upon completing the survey and weight/height assessment, participants received a letter of appreciation from the PI, thanking them for their participation in the study (see Appendix E). Participants who are interested in receiving a summary of the study results were given the option of writing their e-mail address on a sheet of paper near the door on their way out. The e-mail addresses were kept separately from the surveys and destroyed once they were entered into a password-protected database only accessible to the PI. After data collection and analysis has been completed and the project has been approved by the PI's committee, a summary of the study findings will be e-mailed to study participants who requested it as well as to the leadership of each participating unit to disseminate to their personnel. Additionally, the principal investigator will provide a written summary of the study findings to base leadership. Implications regarding weight management prevention and intervention efforts, including base food environment modifications, will be provided as appropriate in this summary.

Measures

Below is a description and rationale for the measures that were used for the predictor and outcome variables of this study. Measures for the demographic, lifestyle, and occupational factors examined in relation to the primary variables of interest are reviewed. The survey (see Appendix C) contains the measures that were used in the current study except for objective proximity to food outlets and BMI, which are described below.

Predictor Variables

Objective Proximity

The main predictor variable in this study is proximity. For the purposes of this study, proximity was operationally defined as the average distance from the unit's building to all base food outlets, based on a approach described by Apparicio and colleagues (Apparicio, Cloutier, & Shearmur, 2007). Research has shown Euclidean distance, or straight-line distance, to be an approximation of travel time (Zenk, Schulz, Israel, James, Bao, & Wilson, 2005). In large population studies, distances from a particular location (usually home) to each food outlet is often done using geocoding or Global Information Systems (Algert, Agrawal, & Lewis, 2006; Berke, Koepsell, Moudon, Hoskins, & Larson, 2007; King, Belle, Brach, Simkin-Silverman, Soska, & Kriska, 2005; Michael, Beard, Choi, Farquhar, & Carlson, 2006). However, given that this study involves a small number of workplaces and food outlets, Euclidean distance from unit buildings to base food outlets was measured using a Garmin GPS 12 XL device, which has accuracy within 15 meters (49 feet; Garmin, 1999). In order to adjust for the curvilinear path of travel from one side of the base to the other (due to the flight line separating the West and East sides of the base), a car odometer was used to more accurately calculate the distance from one side of the base to the other.

Objective Proximity Comparison Groups

The proximity comparison groups consisted of two naturalistic groups of personnel who work in buildings with different average proximity to base food outlets. Participants in the close proximity group were recruited from buildings with an average distance of < 1600 meters of base food outlets or had at least 15/20 food outlets within

1600 meters of where they worked. The upper end of the “within walking distance” range in the literature (1600 meters) was selected as the cut-off point the close proximity group, given that people may drive as opposed to walk to food outlets during the spring months, when the participants were recruited. Twelve participants in the close proximity group reported working in a building with an average distance > 1600 meters but < 2000 meters. These 12 cases were retained in the sample because they 1) worked in buildings with at least 15/20 food outlets within 1600 meters, and 2) the results for the proximity-related hypotheses (1a, 1b, and 1c) did not change when these cases were excluded. Overall, the close proximity group participants worked in buildings with a mean distance of 1380 meters (*SD* = 0.19) to base food outlets.

Participants in the far proximity group were recruited from buildings with an average distance of > 3200 meters of base food outlets with no more than 3/20 food outlets within 1600 meters. An average distance of > 3200 meters was chosen for the far proximity group because it exceeds what is typically examined with regard to food proximity in the literature (i.e., food outlets within two miles of work or home; Jeffery et al., 2006). Overall, the far proximity group participants worked in buildings with a mean distance of 4370 meters (*SD* = 0.37) to base food outlets, which was more than 3 times the average distance of the close proximity group participants to base food outlets.

Additionally, frequency of car use to obtain foods from base food outlets was assessed. However, examination of the data obtained for the car use variable revealed that some personnel misinterpreted the question. Therefore, the car use variable was deemed not to be valid measure of car use and not included in the data analysis.

Perceived Proximity and Other Perceived Aspects of the Food Environment

Given that perceptions of the food environment may influence eating behavior independently of objective measures of the environment (Booth et al., 2005), the following perceived aspects of the base food environment were assessed using 6-point Likert scales: distance to base food outlets (i.e., proximity), convenience of eating food from base food outlets (i.e., time and effort), and taste, affordability, and nutritional value of base food options. This measure was used to examine the relationship between perceived aspects of the base food environment and frequency of eating at base food outlets in Aim 2. Additionally, participants were asked to rate how important each of these factors was in influencing their base food choices using 4-point Likert scale with anchor points 1=Not at all important and 4=Very Important (see Appendix C). The latter measure was based on questions from the Food Choice Questionnaire, which has been shown to have adequate convergent validity and reliability (Steptoe, Pollard, & Wardle, 1995). This measure also was used to describe and examine the relative importance that military personnel place on different aspects of the food environment when making food choices. This information may help inform how to prioritize environmental interventions on base (e.g., if nutritional value is found to be an important factor, increase the availability of healthy food options).

Outcome Variables

The primary outcome variables in this study were frequency of base food consumption, BMI, and PRT score. Each of these variables is operationalized below.

Frequency of Base Food Consumption

A limitation of past research is failing to directly assess frequency of food outlet use (Kipke et al., 2007). Given that the relation between proximity to food outlets and BMI may be indirect, it is important to assess the frequency with which individuals consume food from base food outlets (Kipke et al., 2007). Given that military personnel may eat foods obtained from base outlets at their workplace or even at their desk, away from home foods were defined based on where they were obtained, not where they were consumed (French, 2005). Frequency of base food consumption was assessed using a one-week recall, asking participants to record how often they ate food from each of 16 food outlets on base in the last seven days, including both meals and snacks (see Appendix C).

To examine the association between base food consumption frequency and workplace proximity to base food outlets (H1a), base food consumption frequency in this analysis was created by summing the number of times participants reported eating food from the food outlets on the West side of base (i.e., the food outlets that are closest for the close proximity group and farthest away for the far proximity group; see survey question #1 in Appendix C; last 3 outlets located on East side of base were excluded). This operational definition was used in order to more accurately capture the impact of food proximity on eating behavior, since some personnel on the East side of base (i.e., personnel in the far proximity group) had 0-3 outlets within 1 mile of their work building. Using this operational definition, it was expected that far proximity group personnel (working on the East side of base) would eat food from food outlets on the West side of base less often than close proximity group personnel. For the remaining analyses in Aim

1, all base food outlets on both sides of the base (i.e., regardless of where they were located) were included when calculating base food consumption frequency, in order to examine how the base food environment as a whole may be influencing weight and fitness among military personnel.

BMI

BMI was assessed by formally assessing each participant's current height and weight in inches and pounds, respectively, in accordance with procedures outlined in AFI 10-248 (U.S. Department of the Air Force, 2006). Height and weight was assessed by having participants remove their shoes. Height was measured using a Seca 214 stadiometer, rounded to the nearest inch (i.e., rounded down to the nearest inch if the height fraction is < ½ inch; rounded up to the nearest inch if the height fraction is ≥ ½ inch). Personnel were instructed to stand up straight and look directly forward, with their chin parallel to the floor. Weight was measured using a Tanita HD351 Digital Weight Scale and rounded to the nearest pound. The same height/weight equipment was used at every assessment for standardization purposes. After the raw height and weight data was entered into the SPSS database, an adjusted weight variable was created in which two pounds were subtracted from the raw weight in order to compensate for the uniform worn during the assessment, in accordance with AFI 10-248 (U.S. Department of the Air Force, 2006). Each participant's BMI was then calculated based on the height and adjusted weight for each participant by using the following formula: [Weight in pounds / (Height in inches x Height in inches)] x 703 (U.S. Department of the Air Force, 2006).

PRT score

Although research has demonstrated that overweight is a risk for low physical fitness among Air Force personnel (Robbins, Chao, Fonseca, Snedecor, & Knapik, 2001), BMI is not necessarily a consistent predictor of physical fitness in military personnel (Haddock, Pyle, Poston, Bray, & Stein, 2007). Therefore, the Air Force's current measure of fitness (i.e., PRT score, as described in the introduction) was included as an outcome measure in the current study. Participants were asked to provide their last PRT score via self-report in the survey.

Lifestyle Measures

Physical Activity

International Physical Activity Questionnaire (short form). The International Physical Activity Questionnaire (IPAQ), short form, is a self-report measure that assesses planned exercise, recreational, and lifestyle activities in the last 7 days (IPAQ, 2002, see Appendix C). The form was developed for adults ages 15-69 years. A recent study found the short form has good test-retest reliability (r = .80) and has criterion validity (r = .30) that is similar to other self-report measures of physical activity (Craig et al., 2003). A continuous score of MET-minutes/week was computed for each participant (IPAQ, 2005). IPAQ scores were used to adjust for differences in BMI that may be explained by activity level as opposed to the predictor variables of interest in hypotheses 1b (food proximity) and 1d (base food consumption frequency).

Given the number of personnel with missing data on the physical activity MET minutes/week composite variable (n = 29), mean substitutions were used for personnel who indicated they were "not sure" how many minutes of vigorous, moderate, or walking

they had engaged in on an average day in the last 7 days, in order to maximize the power for the MRC analyses. An examination of the histograms before and after adjusting the variable revealed that the distributions looked similar, suggesting that this was a reasonable substitution.

Diet Quality

A rapid food screener that assesses fat intake and fruit and vegetable intake in the past year was used to measure the overall diet quality of the participants (Block, 2000; C. Hunter, personal communication, April 27, 2007; See Appendix C). The screener takes less than five minutes to complete and has been found to be comparable to the full-length Block Food Frequency Questionnaire in ranking participants with respect to parameters of fat intake (r > .60) and fruit and vegetable servings (r = .71; Block, 2000). This measure was chosen because it is valid and reliable, yet short in order to decrease participant burden. Frequency of eating at base food outlets (which are primarily fast food outlets) may be associated with overall poor diet quality (Astrup, 2005). Therefore, diet quality scores for fat intake and fruit and vegetable intake were calculated using the Block algorithms (Block, 2000) in order to examine the relationship between diet quality and frequency of base food consumption, BMI, and PRT score.

Eating Out Frequency (Off-Base)

In addition to diet quality, off-base eating out frequency (i.e., fast food and sit-down restaurant use both during and outside of work hours) was assessed in order to examine how other micro-environments (e.g., home, school, church) may influence eating behavior and BMI among military personnel.

Dieting Status

Given research that reports that military personnel may lose a large amount of weight (i.e., 10 pounds) prior to weigh-in (Carlton et al., 2005), it appears that many military personnel can be effective at losing weight in the short term. Therefore, an exploratory analysis examined whether or not current dieting status (coded as no=0 and 1=yes) was negatively associated with BMI using a *t*-test.

Commute Time

One research study showed that longer commute times was associated with higher BMI (Frank et al., 2004). Average commute time in minutes was assessed in the survey. Both average time to get to work and average time to get home from work were included in the survey, since these two times can differ dramatically from one another in the Washington, DC area. This measure was used in an analysis to examine whether or not commute time is positively associated with BMI or negatively associated with fitness.

Smoking Status

Given the inverse relationship between smoking and BMI (Ewing et al., 2006), current smoking status was assessed in this study. A preliminary analysis examined the relationship between current smoking status and BMI.

Measures of Occupational Factors

Work Hours

Given that the purpose of this study is to examine the impact of the base food environment on eating behavior, it is important to adjust for other factors that may be associated with frequency of base food consumption. Someone who worked long hours in the last seven days may be more likely to have reached for the "quick and convenient"

food options than someone who worked regular or fewer hours during that time. One way to measure workload is to ask how many hours a person worked in the last 7 days (Wardle et al., 2000). Therefore, number of work hours in the last seven days was assessed in the survey and adjusted for in the analysis examining the association between proximity to base food outlets and frequency of base food consumption in the last seven days.

Perceived Stress

The Perceived Stress Scale (Cohen & Williamson, 1988) is a 10-item self-report measure of the degree to which a person appraises life situations as stressful (see Appendix C). It is a valid measure of global stress, and its internal reliability (alpha coefficient = .78) is slightly better than the original 14-item instrument (Cohen, Kamarck, & Mermelstein, 1983). Given the stressful nature of the current operation tempo and war, and given the research that has shown that people tend to increase their energy, fat, and sugar intake when they are stressed (Oliver et al., 2000), a preliminary analysis examined the association between PSS-10 scores and frequency of base food consumption.

PRT Cycle

As mentioned above, research has demonstrated that some military personnel go on a strict diet two months before their annual PRT, and they may lose as much as 10 pounds in preparation for a weigh-in/PRT (Carlton et al., 2005). It is possible that the weight that is lost in preparation for the PRT is regained as time since last PRT increases (up until about two months prior to the next PRT). Therefore, approximate date of last PRT (month and year) were used in a correlational analysis to examine the relationship

between date of last PRT and BMI. The approximate date of next PRT also was included in the survey to capture personnel who may be watching their eating habits and weight because they have to retest within 90 days (as opposed to one year later) due to a marginal or failed score on their last PRT.

Demographic Factors

As reviewed in the introduction, demographic factors (i.e., gender, age, and race/ethnicity) are differentially associated with eating habits (Jeffery et al., 2006; Pereira et al., 2005) and weight (Bray et al., 2006; Ogden et al., 2006). Therefore, it is important to adjust for these factors when examining the relationship between 1) food proximity and frequency of base food consumption, and 2) frequency of base food consumption and BMI. Given that differences in SES have been found to differentially affect eating habits and weight (Drewnowski & Darmon, 2005; Townsend, 2006), rank was included in this study as a proxy of SES. Preliminary analyses examined the associations between BMI and marital status and education level.

Power Analysis

Previous research was used to calculate expected effect sizes for the proposed study. Power analyses were conducted for the three primary relationships of interest: 1) food proximity and base food consumption, 2) food proximity and BMI, and 3) base food consumption and BMI.

Relationship between proximity to base food outlets and base food consumption. In a telephone survey of residents living in the state of Minnesota, Jeffery and colleagues (2006) found a positive association (r = .30), which is a medium effect size (d = .63), between number of fast food restaurants within two miles of home and frequency of fast

food use in the past week. Considering the large number of fast food outlets (20) on Andrews AFB and the difference in the prevalence of base food outlets within two miles in the comparison groups in the proposed study (i.e., 15-17 vs. 0-3 food outlets within 1 mile of the workplace), it was expected that the relationship between proximity to base food outlets and base food consumption in the current study also would have a medium effect size.

Relationship between food proximity and BMI. Maddock's (2004) study examined the relationship between the prevalence of fast food restaurants and BMI (i.e., self-reported height and weight) using a state-level analysis and aggregate data. A strong negative association (d = 1.55; large effect size) was found between number of residents per fast food restaurant and obesity (percent of residents with a BMI $\geq$ 30 kg/m^2), such that a higher prevalence of fast food restaurants was positively associated with percent obese. Although proximity was not assessed per se, the study results suggest support for a medium effect size when examining the relationship between prevalence of fast food restaurants and obesity. In the current study, the prevalence of food outlets on the West side of base (17 food outlets) is much greater than the prevalence of food outlets on the East side of base (3 food outlets). Further, the proposed study 1) used individual data as opposed to aggregate data, and 2) used an objective and continuous measure of BMI as opposed to a self-report and dichotomous measure of BMI, which is intended to help decrease measurement error and increase the power from Maddock's (2004) study. As a conservative measure, it was estimated that the relationship between proximity to base food outlets and BMI will have a medium effect size in the proposed study.

Relationship between base food consumption and BMI. The Pound of Prevention study (French et al., 2000) found that women who ate an average of 3.3 fast food meals per week had a BMI that was 2.8 kg/m^2 higher than women who ate an average of 0 fast food meals per week. This data revealed a medium effect size (d = .5) when examining the relation between fast food consumption frequency and BMI (Cohen, 1988). This effect size was determined by first calculating the pooled standard deviation for the low-fast food frequency and high-fast food frequency groups using the standard error of the mean from each group (Zakzanis, 2001), and then calculating Cohen's *d* from there (Cohen, 1988). Additionally, a telephone survey of Minnesota residents (Jeffery et al., 2006) revealed a Beta coefficient of .30 (i.e., a medium effect size) when examining the relationship between BMI (based on self-reported height and weight) and fast food use (0 times vs. $\geq$ 1 time in the past week). The current study used a continuous measure of base food consumption frequency.

A rule of thumb using the smaller effect size above (d = .5, or medium effect size) and number of predictors was used to determine the number of subjects needed for multiple regression correlation analysis (Green, 1991). Based on the literature, Green's rule of thumb, and nQuery regression power calculations, a sample size of 125 participants would be sufficient to test the hypotheses in this study at > 80% power and an alpha < .05 (two-tailed). However, because this study took place within a single environment (work vs. home) with a categorical measure of proximity, it was thought that the effect size in the proposed study may not be as robust as that found in the literature. Therefore, as a conservative measure, it was estimated that this study would reveal an effect size of R^2 = .08, which would require an additional 53 participants to

detect (see Table 1). 192 participants were recruited for the current study. Based on a sample size of 178 participants (which allows for some missing data in the analyses), the proposed study was adequately powered to detect a Model $R^2 \geq .08$ (An R^2 of .13 is considered a medium effect size), a partial $R^2 \geq 0.03$ with covariates in the model that explain $\geq$ 30% of the variance in the outcome variable, a single covariate (i.e., proximity) Model $R^2 \geq .05$, and an $r \geq .25$.

Table 1. Power Analysis.

Model R^2	**Sample Size** *N*	**Partial** R^2	**Single Covariate** R^2	**Correlation** *r*
.13	125	.03	.06	.25
.09	153	.03	.05	.25
.08	178	.03	.05	.25

III. RESULTS

Sample Characteristics

Sample demographics (both overall and by proximity group) are depicted in Table 2. The majority of the sample was male (80.6%), Caucasian (58.4%), and married (55.5%). Military characteristics relevant to the current study are depicted in Table 3. The majority of personnel were enlisted (90.5%) and lived off base (72.8%). Participants had been stationed at Andrews AFB for an average of 3.6 years (*SD* = 5.10) and had been in the Air Force for an average of 10.8 years (*SD* = 8.20). Compared to the Air Force population as a whole, the study sample had a greater percentage of racial/ethnic minorities (41.6% vs. 26.5%) and enlisted (90.5% vs. 80.1%) personnel (Air Force

Personnel Center, 2009). Compared to the military as a whole, the sample had more women (19.4% vs. 14%), more racial/ethnic minorities (41.6% vs. 36%), more enlisted (90.5% vs. 83.9%), and was a little older (mean age of 31 vs. 27 years; DMDC, 2005). Table 4 illustrates participants' health characteristics. The majority of the participants (n = 104, 54.2%) were overweight (i.e., BMI between 25-29.9 kg/m^2). Nearly 19% of the participants (n = 36) had a BMI in the obese range (BMI $\geq$ 30 kg/m^2). The majority of respondents (78.3%) reported eating food from base food outlets (excluding the dining halls) at least once in the last seven days, and half of the participants (51.6%) reported eating food from base food outlets at least three times in the last seven days. On average, participants reported eating food from base food outlets 5.2 times (SD = 4.7) in the last seven days. Additionally, participants reported eating food from snack shacks or vending machines in their work buildings an average of 2.8 times (SD = 4.4) in the last seven days.

Group differences. The close and the far proximity groups differed from one another by gender, marital status, physical activity level, and commute times. The close proximity group contained more male participants (87.9%) compared to the far proximity group (71.6%; $\chi^2(1) = 7.79$, p = .005, φ = -.20; see Table 2). The far proximity group contained more married participants (62.5%) than the close proximity group (48.5%; $\chi^2(1) = 4.33$, p = .037, φ = -.15; see Table 2). Participants in the close proximity group also endorsed spending more hours per day engaging in physical activity (M = 2.57, SD = 3.22) in the last seven days than participants in the far proximity group (M = 1.69, SD = 1.92; $t(162.44) = -2.30$, p = .008, d = 0.33; See Table 4). Participants in the close proximity group also had greater daily physical activity metabolic equivalent (MET; M =

722.55, SD = 716.85) in the past week than participants in the far proximity group (M = 481.11, SD = 469.80; $t(170.64) = -2.76$, $p = .006$, $d = 0.40$). It should be noted that PA minutes and PA METs were significantly correlated with one another $r_s(192) = -.97$, $p < .001$, so only PA METs (which takes exercise intensity into account) was used as a covariate in the following analyses as appropriate. Participants in the close proximity group also reported spending fewer minutes commuting to and from work (M = 55.92, SD = 41.33) compared to the far proximity group participants (M = 74.87, SD = 46.51; $t(186) = 2.96$, $p = .004$, $d = 0.43$). Therefore, gender, marital status, physical activity METs, and commute time were included as covariates to account for their potential confounding effects in the following analyses as appropriate.

Data transformations

Several data transformations were made in order to prepare for the MRC analyses. First, dichotomous variables were coded as 0 and 1, with the reference group coded as 0 (i.e., the proximity group variable was coded as far proximity group = 0 and close proximity group = 1; gender was coded as male = 0, female = 1). Second, several categorical variables which have more than two categories were recoded into new variables with fewer categories and then were dummy coded for the MRC analyses described below. Marital status was recoded from 4 categories (never married, married, divorced, widowed) to 2 categories (not currently married = 0, currently married = 1). Residence was recoded from 4 groups (base housing – West side, base housing – East side, dormitory, off-base) to 3 groups (dormitory vs. base housing vs. off base), with off base serving as the reference group. Education level (Grade 12 or GED vs. some college or technical school vs. Bachelor’s degree vs. some graduate school vs. advanced degree)

was dummy coded, with “some college or technical school” serving as the reference group. A combined race/ethnicity variable was created (Hispanic vs. African American vs. Asian vs. Caucasian vs. Other), in which Caucasian served as the reference group.

Third, normality assumption of the scores was examined for the continuous outcome variables and was secured by data transformations if not met. The base food consumption frequency variable was transformed via a natural log algorithm to address the positively skewed distribution. PRT score contained two major outliers, defined as having a score greater than three standard deviations below the mean. Because any score below 75 is considered to be a failing score according to the Air Force standards (Department of the Air Force, 2006), the two outliers (both failing scores) were adjusted to having a score within 3 standard deviations of the mean (i.e., one 1 point less and one 2 points less than the lowest score that fell within 3 standard deviations). The adjusted PRT scores met the homogeneity of variance assumption. However, the adjusted PRT scores distribution was negatively skewed, so the adjusted PRT scores were then transformed via a natural logarithm to meet the normality assumption. Finally, the distribution of BMI scores met the normality assumption based on the Kolmogorov-Smirnov test (K-S = .04, df = 192, p = .200), so the BMI variable was not transformed.

Preliminary Analyses

Correlational analyses were performed to identify factors that may be associated with the outcome variables in the current study (base food consumption frequency, BMI, and PRT score). Factors significantly associated with the outcome variable and with a plausible explanation for that association were included as covariates in the MRC

analyses to adjust for potential confounding effects. Additionally, based on previous literature, some other factors were included as covariates.

Factors associated with base food consumption frequency. Frequency of base food consumption was negatively associated with age, $r_s(183) = -.31$, $p < .001$ (one-tailed), suggesting that younger personnel ate at food outlets more often than older personnel, which is consistent with the literature to date. A Mann-Whitney test revealed that personnel who were not currently married ($Mdn = 5.0$) ate food from base food outlets more often than personnel who were married ($Mdn = 3.0$; $U = 2{,}648.50$, $p < .001$, $r = -.41$). In addition, a Kruskal-Wallis test revealed that frequency of base food consumption differed by place of residence, $H(2) = 31.32$, $p < .001$. Between-residence differences were further examined by Mann-Whitney tests. A Bonferroni correction with a significance level of .025 was applied. Personnel living in the dormitories on base reported eating at base food outlets more frequently than personnel living off base, $U = 438.50$, $r = -.40$, $p < .001$. In contrast, there was a trend for personnel living in base housing reported to eat food from base food outlets less often than personnel living off base, $U = 1{,}607.50$, $r = -.16$, $p = .029$, although it was not statistically significant when using the Bonforroni correction. Men ($M = 4.18$, $SD = 4.08$, $Mdn = 6.00$) did not significantly differ from women ($M = 4.17$, $SD = 3.27$, $Mdn = 4.00$) in frequency of base food consumption, $U = 2{,}446.00$, $p = .607$, $r = -.04$. However, gender was retained as a covariate because 1) there was a trend in the hypothesized direction, 2) previous research studies have found that men tend to eat away-from-home foods with greater frequency than women, and 3) the proximity groups differed by the proportion of men and women. Therefore, gender, age, marital status, and residence were included as covariates for H1a.

Also, work hours in the past week was included as a potential confounding factor, since people who worked more hours may have more opportunities to eat base food than personnel who worked fewer hours.

Excluded variables. Several other variables were not included as covariates because they were not significantly associated with the outcome variable (base food consumption frequency). There was no association between health condition (yes vs. no) and base food consumption frequency, $r_{pb}(183) = -.11$, $p = .13$, so it was not included as a covariate. Only 10.9% of the sample ($n = 21$) endorsed having one or more health conditions. Although 24.1% of the sample ($n = 46$) reported they were currently dieting to lose weight, they did not significantly differ in frequency of base food consumption (*Mdn* = 3.00) from individuals who reported they were not currently dieting (*Mdn* = 4.00; $U = 2802.50$, $p = .356$, $r = .07$). A Kruskal-Wallis test revealed that frequency of base food consumption did not differ by education level, $H(4) = 8.01$, $p = .091$. Personnel reported that weather conditions prevented them from going to base food outlets an average of 0.31 times in the past week (*SD* = 0.82). A Spearman correlation analysis revealed that frequency of base food consumption was not associated with the number of times people reported the weather prevented them from going to base food outlets, $r_s(184) = .06$, $p = .39$. Frequency of base food consumption also was not associated with assessment order, $U = 4141.50$, $p = .818$, $r = .02$. Personnel who filled the survey out first (*Mdn* = 4.00) did not report eating at food outlets any less than personnel who completed the height/weight assessment first (*Mdn* = 4.00).

Additionally, there were three variables that were excluded as covariates because their association with base food consumption frequency appeared to be accounted for by

one of the covariates included in the analysis below. There was a significant association between frequency of base food consumption and perceived stress, $r_s(183) = .16$, $p = .03$. However, this relationship became non-significant when adjusting for gender, suggesting that gender may account for this association, which is supported by some previous research (Zellner et al., 2006; Zellner et al., 2007). Women ($M = 15.51$, $SD = 6.92$) had higher average perceived stress scores than men ($M = 12.65$, $SD = 6.38$; $t(188) = -2.41$, $p = .017$, $d = -0.43$). Because gender is already included as a covariate, perceived stress was not included as a covariate. Although rank was associated with frequency of base food consumption, $r_s(182) = -.33$, $p < .001$, this relationship became non-significant when adjusting for age. Because age was already included as a covariate, rank was not included as a covariate. There was a significant association between frequency of base food consumption and commute time, $r_s(183) = -.16$, $p = .03$. However, this association became non-significant when adjusting for place of residence, so commute time was not included as a covariate.

Factors associated with BMI. Analyses were performed to identify factors associated with the outcome variable (BMI). There was a significant association between gender and BMI, $r_{pb}(191) = -.21$, $p = .004$, such that that men ($M = 27.41$, $SD = 3.39$) had a higher BMI than women ($M = 25.59$, $SD = 3.54$; $t(189) = 2.92$, $p = .004$). There also was a positive association between age and BMI, $r_s(191) = .20$, $p = .007$, suggesting that as age increased, BMI increased. A Kruskal-Wallis test revealed that BMI differed by race/ethnicity, $H(4) = 10.43$, $p = .034$. Therefore, gender, age, and race/ethnicity were included as covariates in the MRC analysis below.

Two other potential confounding variables were included in the MRC analyses. Given that it may take time for an environmental influence (such as workplace proximity to food) to affect BMI, time stationed at Andrews (in years) was included as a covariate in the analysis below. Although the association between self-report physical activity (in METs) and BMI was not significant, $r_s(163) = .08$, $p = .446$, physical activity (METs for the last 7 days) was included as a covariate because 1) exercise has been shown to influence BMI in the literature, and 2) the physical activity rates differed by proximity group.

Excluded variables. Based on research findings in military and civilian literature, it was expected that PRT score, current dieting, current smoking, physical activity, and education level would be negatively associated with BMI. Being married was expected to be positively associated with BMI. Independent *t*-tests were conducted to assess the association between BMI and dichotomous factors (dieting status, smoking status, and marital status). Twenty-five percent of participants ($n = 47$) reported they were currently dieting to lose weight. On average, participants who reported that they were currently dieting to lose weight ($M = 28.80$, $SD = 3.26$) had a greater BMI than participants who reported that they were not currently dieting ($M = 26.45$, $SD = 3.40$). This difference was significant, $t(186) = -4.15$, $p < .001$, $r = .29$; however, it was opposite of the expected direction, suggesting that dieting in this case may be a marker for overweight (as opposed to a factor that may lowering one's weight, as hypothesized). Therefore, it was not included as a covariate in the analysis. Twenty-seven percent of participants ($n = 51$) reported currently smoking. On average, participants who reported currently smoking ($M = 26.68$, $SD = 2.68$) did not differ in BMI from participants who reported that they were

not currently smoking (*M* = 27.22, *SD* = 3.75; *t*(124.3) = 1.11, *p* = .136 (one-tailed), *r* = .10). Approximately half (55.5%) of the sample reported they were currently married (*n* = 106). On average, participants who reported being currently married (*M* = 27.38, *SD* = 3.15) did not significantly differ in BMI from participants who reported that they are not currently married *M* = 26.62, *SD* = 3.86; *t*(156.50) = -1.46, *p* = .073 (one-tailed), *r* = .11.

Additional exploratory analyses. Additional analyses were conducted to examine the association between BMI and the following factors: education level, commute time, and military factors (including fitness level, time away from base, job type, duty status, and PRT cycle). A Kruskal-Wallis test revealed no significant differences in BMI by education level, *H*(3) = 2.31, *p* = .511. An independent samples *t*-test revealed that BMI did not differ between personnel who worked a support/desk job (*M* = 26.81, *SD* = 3.40) and personnel with operational jobs (*M* = 27.21, *SD* = 3.53; *t*(190) = -0.78, *p* = .438, *r* = .06). BMI also did not differ between active duty personnel (*M* = 27.13, *SD* = 3.61) and full-time Guard and Reserve personnel (*M* = 26.75, *SD* = 2.92; *t*(190) = 0.61, *p* = .546, *r* = .04). A Spearman correlation analysis revealed no significant association between number of months since last PRT and current BMI, r_s = -.073, *p* = .329. There also was no significant association between BMI and total daily commute time to and from work, r_s = .10, *p* = .182. A Spearman correlation analysis revealed a positive association between BMI and percent of time spent away from base, r_s = .18, *p* = .012, suggesting that greater time spent away from base was associated with higher BMI. It is possible that those who spend more time away from base tend to travel more as part of their work, which may lead them to eat out more and therefore have a higher BMI.

Factors associated with PRT score. Several variables were significantly associated with PRT score and included as covariates in the MRC analysis below. There was a significant negative association between BMI and PRT score, $r_s = -.46$, $p < .001$, suggesting that as BMI increased, PRT scores decreased. This finding supports previous military research findings in which higher BMI is associated with lower levels of physical fitness (Troumbley et al., 1990). There was a significant negative association between commute time and PRT score, $r_s = -.19$, $p = .012$, suggesting that longer commute time was associated with lower PRT scores. There was a significant association between marital status and PRT score, $U = 3{,}321.00$, $p = .046$, $r = -.15$, such that individuals who were currently married reported lower PRT scores ($Mdn = 84.00$) than individuals who were not currently married ($Mdn = 87.00$). A Kruskal-Wallis test revealed a significant differences in PRT score by place of residence, $H(2) = 10.21$, $p = .006$. Post hoc, bonferroni-adjusted, Mann-Whitney tests revealed that compared to people who lived in the dormitory ($Mdn = 90.00$), people who lived off base ($Mdn = 85.00$) reported lower PRT scores, $U = 972.00$, $p = .002$, $r = .23$. However, there was no significant association between age and PRT score, $r_s(181) = .12$, $p = .116$, which is not surprising, given that fitness requirements for passing the PRT decrease with age. Also, there were no significant associations between PRT score and both total physical activity METs, $r_s(182) = .014$, $p = .849$, and vigorous physical activity METs, $r_s(182) = .117$, $p = .115$.

Aim 1: Easier physical access to food would be associated with greater frequency of food consumption, higher BMI, and lower PRT score.

Hypothesis 1a. Workplace proximity to base food outlets would be positively associated with base food consumption frequency.

MRC analysis for H1a. A hierarchical multiple regression correlation analysis (MRC) was used to test the hypothesis that closer workplace proximity to base food outlets would be positively associated with frequency of base food consumption. Workplace proximity was the predictor variable and food consumption frequency from outlets on the West side of base was the outcome variable. Covariates were entered into the analysis in the first block (gender, age, marital status, residence, and work hours). The dichotomous predictor variable (i.e., close vs. far workplace proximity to base food outlets) was entered in the second block.

Prior to the hierarchical MRC, workplace proximity was entered into the regression alone to assess the association between workplace proximity and base food consumption frequency without adjusting for covariates. Workplace proximity was associated with base food consumption frequency, $B = 0.10$, $\beta = .18$, $t(178) = 2.49$, $p = .014$, accounting for 2.8% of the variance in base food consumption frequency (See Table 5). Results from the hierarchical MRC showed that workplace proximity remained significantly associated with frequency of base food consumption, $B = 0.08$, $\beta = .15$, $t(169) = 2.04$, $p = .043$, after adjusting for the covariates. Workplace proximity accounted for an additional 1.9% of the variance in base food consumption frequency after adjusting for covariates (See Table 6). In support of the hypothesis, results from the hierarchical regression revealed that personnel who worked in buildings with closer

proximity to the food outlets on the West side of base (*M* = 4.87, *SD* = 4.40) reported eating food from them 1.08 times more often in the last seven days than personnel who worked in buildings farther away from those food outlets (*M* = 3.40, *SD* = 3.24), after holding the covariates constant.

Exploration of a possible moderation effect. Given that the close proximity group had more male personnel than the far proximity group, the above MRC analysis was re-run with gender excluded (see Table 7). When gender was excluded as a covariate, the association between proximity group and base food consumption frequency became non-significant, suggesting that gender may be having a moderating effect. Therefore, an exploratory moderation analysis was conducted with the inclusion of a gender x proximity group interaction term in the third step of the MRC described above (See Table 8). The addition of the interaction term approached significance, $B = -0.19$, $\beta = -.16$, $t(168) = -1.19$, $p = .056$. An examination of cell means revealed that men in the close proximity group (*M* = 5.04, *SD* = 4.53) appeared to eat food from base food outlets more often than men in the far proximity group (*M* = 2.98, *SD* = 3.08), whereas women's consumption of base food did not appear to differ by close (*M* = 3.40, *SD* = 2.76) vs. far (*M* = 4.48, *SD* = 3.45) proximity group. However, given the limited number of women in the study sample, this finding should be interpreted with caution.

To see if the relationship between closer food proximity holds in men, an MRC analysis was run with only the male participants (see Table 9). Results revealed a significant association between workplace proximity to base food outlets and base food consumption among men, $B = 0.11$, $\beta = .19$, $t(168) = 2.56$, $p = .011$. This association remained significant when marital status or place of residence, or both were removed as

covariates. However, there were few male participants (n = 20) who lived in the dorms, which may explain why no association was found. Anecdotally, an examination of means suggests that men who live in the dorm (M = 9.71, SD = 5.01) appear to eat food from base food outlets more often than men who do not live in the dorm (M = 3.26, SD = 3.09). There was inadequate power to examine the association between workplace proximity to base food outlets and base food consumption frequency in women, given the small number of women in the study. Therefore, the association between workplace proximity to base food outlets and base food consumption frequency remains inconclusive.

Hypothesis 1b. Workplace proximity to base food outlets would be positively associated with BMI.

MRC analysis for H1b. This hypothesis was tested using a hierarchical multiple regression correlation analysis (MRC). BMI was the outcome variable and workplace proximity to base food outlets (close vs. far) was the predictor variable. Covariates significantly associated with BMI were entered into the equation in the first block (gender, age, race/ethnicity), along with potential confounding variables (time on station and physical activity METs). The dichotomous predictor of interest (i.e., close vs. far workplace proximity to base food outlets) was entered in the second block.

Contrary to expectation, workplace proximity to base food outlets was not associated with BMI prior to adjusting for covariates, B = 0.31, β = .04, $t(186)$ = 0.60, p = .549 (See Table 10). Results from the hierarchical MRC revealed no significant effect of workplace proximity on BMI after adjusting for covariates, B = -0.11, β = -.02,

$t(175) = -0.21$, $p = .835$ (See Table 11). These results suggest that the BMI of personnel did not differ by workplace proximity to base food outlets.

Exploratory moderatation analysis. The hierarchical MRC analysis was run again with moderators of interest (gender, race/ethnicity, and physical activity). Moderation was tested by interaction terms of gender x proximity, race/ethnicity x proximity, and physical activity x proximity, which were entered in the third block. The gender interaction term was calculated by multiplying gender by proximity group. The race/ethnicity x proximity group interaction terms (4 total) were calculated by multiplying each race/ethnicity dummy variable by proximity group. The physical activity interaction term was calculated by multiplying physical activity (in METs) by proximity group. The addition of the interaction terms in the third step of the hierarchical regression did not result in a significant increase in explained variance of BMI, F (6, 169) = 0.61, $\Delta R^2 = .02$ for Step 2, $p = .772$, suggesting that the non-significant association between proximity group and BMI holds across demographic groups and physical activity level.

Hypothesis 1c. Proximity to base food outlets would be negatively associated with PRT score.

MRC analysis for H1c. This hypothesis was tested using a hierarchical multiple regression correlation analysis (MRC). PRT score was the outcome variable, and frequency of base food consumption was the predictor variable. Covariates significantly associated with PRT score were entered into the equation in the first block (i.e., BMI, residence, commute time, marital status). Because differential access to food in the workplace may impact fitness level over time, time on station was also included as a

covariate in the first block. The predictor of interest (proximity to base food outlets) was entered in the second block.

When proximity group was entered into the analysis alone, it was not significantly associated with PRT score, $B = -0.005$, $\beta = -.08$, $t(176) = -1.01$, $p = .315$ (See Table 12). After adjusting for covariates, there remained no significant effect of proximity group on PRT score, $B = -0.01$, $\beta = -.08$, $t(169) = -1.14$, $p = .256$ (See Table 13). The hypothesis that proximity to base food outlets would be negatively associated with PRT score was not supported.

Hypothesis 1d. Frequency of base food consumption would be positively associated with BMI.

This hypothesis was tested using MRC. BMI was the outcome variable and base food consumption frequency was the predictor variable. Covariates were entered into the equation in the first block (gender, age, race/ethnicity, physical activity METs, and time on station). The predictor of interest (frequency of base food consumption) was entered in the second block.

Prior to the hierarchical MRC, base food consumption frequency was entered into the regression alone to assess its association with BMI without adjusting for covariates. Contrary to expectation, base food consumption frequency was not associated with BMI, $B = -0.10$, $\beta = -.130$, $t(182) = -1.77$, $p = .079$ (See Table 14). Results from the hierarchical MRC showed that base food consumption frequency remained not significantly associated with BMI, $B = -0.10$, $\beta = -.13$, $t(169) = -1.51$, $p = .134$, after adjusting for the covariates (See Table 15). These results suggest no significant association between frequency of consumption from base food outlets and BMI.

Exploratory moderation analysis. Similar to the exploratory moderation analysis for H1b, moderation effects of gender and race/ethnicity on the relation between base food consumption frequency and BMI were tested. The MRC analysis for H1d was repeated with interaction terms (gender x base food consumption frequency, race/ethnicity x base food consumption frequency, and physical activity x base food consumption frequency) entered in the third block. The gender x base food consumption frequency variable was calculated by multiplying gender by base food consumption frequency. The race/ethnicity x base food consumption frequency interaction terms (4 total) were calculated by multiplying each race/ethnicity dummy variable by base food consumption frequency. The physical activity interaction term was calculated by multiplying physical activity (in METs) by base food consumption frequency.

The addition of the interaction terms in the third step in the model did not result in an overall significant increase in explained variance of BMI, F (6, 164) = 0.36, $\Delta R^2 = .03$ for Step 2, $p = .356$, suggesting that the post hoc model of gender and race/ethnicity both acting as moderators was not supported. However, there was a significant gender x base food consumption frequency interaction, $B = 0.38$, $\beta = .30$, $t(168) = 2.03$, $p = .044$. This finding suggests that the association between base food consumption frequency and BMI is moderated by gender. An examination of the relationship between base food consumption frequency and BMI by gender revealed a negative association between base food consumption frequency and BMI among men, $r_s(148) = -.21$, $p = .012$, but not among women, $r_s(35) = .14$, $p = .411$. Men with a lower BMI report eating food from base food outlets more often than men with a higher BMI. One possible explanation for this finding is that men with a lower BMI eat out more because they are not struggling

with weight and fitness. However, given the small sample of women, this finding should be interpreted with caution.

Hypothesis 1e. Frequency of base food consumption would be negatively associated with PRT score.

The same transforms applied to the PRT score variable in H1c were used again in the current analysis. This hypothesis was tested using MRC. PRT score was the outcome variable. Covariates significantly associated with PRT score were entered into the equation in the first block (BMI, commute time, residence, marital status, and time on station). The predictor of interest (i.e., frequency of base food consumption) was entered in the second block.

Prior to the hierarchical MRC, base food consumption frequency was entered into the regression alone to assess its association with PRT score without adjusting for covariates. Base food consumption frequency was not significantly associated with PRT score, $B = 0.001$, $\beta = .12$, $t(173) = 1.61$, $p = .109$ (See Table 16). There was no significant effect of base food consumption frequency on PRT score after adjusting for covariates, $B = -0.00005$, $\beta = -.006$, $t(164) = -0.08$, $p = .940$ (See Table 17). The hypothesis that base food consumption frequency would be negatively associated with PRT score was not supported.

Aim 2: Greater perceived access to food would be associated with greater frequency of food consumption.

Hypothesis 2a. Perceived proximity to base food outlets would be positively associated with frequency of base food consumption.

Mean perceived proximity of food outlets to the workplace was 3.03 (*SD* = 1.60) on a 6-point Likert scale ranging from "very far from where I work" to "very close to where I work," with higher values representing closer perceived proximity to the workplace. A Spearman correlation analysis revealed that perceived proximity to base food outlets was not associated with overall frequency of base food consumption (East and West side combined), $r_s(182) = .09$, $p = .118$ (one-tailed). However, perceived proximity was positively associated with frequency of food consumption on the West side of base, where the majority of food outlets are located $r_s(182) = .16$, $p = .017$ (one-tailed).

Hypothesis 2b. Perceived cost of food at base food outlets would be negatively associated with frequency of base food consumption.

Mean affordability was 1.92 (*SD* = 1.19) on a 6-point Likert scale ranging from "cheap" to "expensive," with lower values representing greater affordability. Overall, personnel rated base food as being relatively "cheap." Contrary to expectation, no association was found between perceived cost and frequency of base food consumption $r_s(181) = -.09$, $p = .114$ (one-tailed).

Hypothesis 2c. Perceived convenience of base food outlets would be positively associated with frequency of base food consumption.

Mean perceived convenience of base food outlets was 3.46 (*SD* = 1.50) on a 6-point Likert scale ranging from "not convenient" to "very convenient," with higher values representing greater convenience. Overall, personnel perceived obtaining food from base food outlets as relatively convenient. Contrary to expectation, perceived

convenience of base food outlets was not associated with frequency of base food consumption, $r_s(181) = .05$, $p = .114$ (one-tailed).

Hypothesis 2d. Objective food proximity would be positively associated with perceived food proximity.

The association between objective and perceived food proximity was examined using a point-biserial correlation, with objective food proximity as the dichotomous variable and perceived food proximity as the continuous variable. As described above, perceived proximity of food outlets to the workplace measured on a 6-point Likert scale ranging from "very far from where I work" to "very close to where I work," with higher values representing closer perceived proximity to the workplace. A point-biserial correlation analysis revealed an association between objective and perceived food proximity, $r_{pb}(186) = .56$, $p < .001$, with 31.6% of the variance in perceived food proximity explained by objective food proximity (near vs. far). Considering that one could argue that proximity is not necessarily a strict dichotomy (i.e., there is an underlying continuum for workplace proximity to base food outlets), a biserial correlation was calculated (Field, 2005). The biserial correlation coefficient ($r_b = .70$) supported the relationship between objective and perceived food proximity. A Mann-Whitney test was conducted to determine the direction of the association between objective and perceived proximity. As expected, participants in the close proximity group (*Mdn* = 4.00) rated base food outlets as generally located closer to their work building compared to participants in the far proximity group (*Mdn* = 2.00), $U = 1{,}562.00$, $p < .001$, $r = .56$.

Additional Analyses for Aim 2. Spearman correlation analyses were performed to examine the associations between frequency of base food consumption and both

perceived taste and perceived nutritional value of food from base food outlets. Based on findings in military and civilian research, it was expected that tastiness and nutritional value would be positively associated with frequency of base food consumption. Mean perceived nutritional value was 1.57 (*SD* = 1.08) on a 6-point Likert scale ranging from "not healthy" to "very healthy," with higher values representing higher nutritious value. This finding suggests that the participants do not perceive base food to be very healthy. Perceived nutritional value was marginally associated with overall frequency of base food consumption, $r_s(181) = .11$, $p = .063$ (one-tailed). Mean perceived tastiness was 2.72 (*SD* = 1.05) on a 6-point Likert scale, ranging from "not tasty" to "very tasty," with higher values indicating higher tastiness. This finding suggests that participants do not perceive base food to be particularly tasty. Contrary to expectation, perceived taste was not associated with overall frequency of base food consumption, $r_s(180) = -.01$, $p = .450$ (one-tailed).

IV. DISCUSSION

Despite the dramatic rise in the prevalence of overweight and obesity among military personnel in recent years, there has been limited research investigating possible reasons for this increase. One proposed reason in the civilian literature is the food environment (i.e., increased availability and accessibility of unhealthy food options). The prevalence of fast food restaurants, other restaurants, and vending machines have increased both in civilian sector and on military installations. One means of examining the impact of the food environment on overweight and obesity in the public health literature is to examine the relationship between proximity of one's residence or workplace to food outlets and frequency of eating food from food outlets. To our

knowledge, this is the first study that examines the relationship between workplace proximity to food outlets and eating behavior in a military population. The overarching hypothesis of Aim 1 in the current study was that closer workplace proximity to base food outlets would be associated with greater frequency of base food consumption, higher BMI, and lower PRT scores.

Discussion of Proximity Group Differences

As noted above, the close proximity group had more male participants, greater levels of physical activity, more non-married participants, and shorter commute times relative to the far proximity group. One possible reason for the greater number of males in the close proximity group may be due to AFSC differences between the groups (e.g., the security forces personnel and aircraft maintenance workers (who both worked on the West side of base) tend to be predominantly male career fields). Regarding physical activity, male participants reported engaged in more minutes of physical activity in the last seven days than female participants. When adjusting for gender, the correlation between proximity group and physical activity became non-significant, which suggests that gender may account for the differential activity levels between proximity groups. The fact that there were more married participants in the far proximity group may explain the shorter commute times in the close proximity group, who had more participants who reported living on base (30% vs. 24%), including the dorm (14% vs. 10%).

Discussion of Aim 1 Results

Food proximity and eating behavior

The hypothesis that personnel who worked closer to base food outlets would report eating food from them more often compared to personnel who worked farther

away from them was supported. This finding corroborates previous research findings that people tend to use resources that are closer by than resources that are farther away (Booth et al., 2005). Given the current ops tempo and decreased manpower (as a result of downsizing), the mission must be accomplished with fewer people than in the past. These demands may place time constraints on personnel, who may be covering multiple duties that would normally be covered by 2-3 people. In order to accomplish the mission, personal health habits may be sacrificed by eating quicker, more convenient meals that are readily available as opposed to bringing one's own lunch or eating healthier foods, the latter of which take more time to prepare or are usually harder to obtain, respectively. However, it is important to note that this association between workplace proximity to base food outlets and base food consumption may be accounted for by gender (i.e., the over-representation of male participants in the close proximity group relative to the far proximity group). Anecdotally, there were more unmarried men and men who lived in the dorm in the close proximity group compared to the far proximity group, which may explain the reason for this finding. However, we were not able to statistically test this hypothesis due to the small sample size in some of the cells.

In support of the idea that convenience may explain the association between workplace proximity to base food outlets and eating behavior, 74.6% of participants in the current study rated convenience as "moderately important" or "very important" to them when deciding where to obtain their food on base. Another finding that lends support to the relationship between food proximity and eating behavior is that personnel in the far proximity group reported eating food within their work building (M = 3.6, SD = 5.2) more often than personnel in the close proximity group (M = 2.2, SD = 3.5; U =

3103.00, $p = .001$, $r = -.25$). This finding makes sense, given that people in the far proximity group would perhaps find it more convenient to eat food from within their own building, which is much closer than going out to get food from a food outlet that is farther away and perhaps considered less convenient. These observations are supported by a study that found that being “too busy” was the primary barrier to eating healthfully in a sample of senior officers attending Army War College (Sigrest, Anderson, & Auld, 2005). Interviews with the base Health and Wellness Center (HAWC) personnel, who often work with individuals who are struggling with overweight, revealed that guides on how to make healthier choices when eating out were popular among service members (S. Bempong, personal communication, April 23, 2008). This observation supports previous research that found that military personnel are interested in learning about “eating healthfully on the run” (Sigrest et al., 2005), which aligns with the traveling inherent in the military lifestyle.

Food proximity and BMI and PRT score

Contrary to study hypotheses, closer workplace proximity to base food outlets was not associated with higher BMI or lower PRT score. There are a number of possible explanations for this null finding. One possible explanation is that personnel usually remain at a duty station for only a few years before they PCS to a new duty station (average time on station was 3.6 years ($SD = 5.1$) in the current sample). Therefore, it is possible that longer times on station would be required to detect differences in BMI and PRT score. Another possible explanation is that other environments may influence weight status among military personnel, such as TDY or deployed settings. In support of this possibility, a positive association found between time away (i.e., TDY, deployed, or

on leave) and BMI was found in the current study. Therefore, it is possible that the travel inherent in military culture masks the influence of the base food environment on the weight and fitness status of military personnel. Also, with regard to the current sample, several food outlets were located within one mile of the far proximity group. In fact, there was no association between workplace proximity to base food outlets and overall base food consumption, suggesting that personnel in the far proximity group ate food from the few nearby food outlets and/or the food outlets farther away (i.e., food outlets on the other side of base). These eating patterns in the far proximity group, including greater frequency of food consumption within one's work building compared to the close proximity group, may explain why BMI and fitness did not differ by workplace proximity to food outlets in the current sample. It is also possible that the relatively limited variance in workplace proximity to food outlets (< 1 mile vs. > 2 mile average distance), BMI (the majority of the sample was overweight), and PRT score (most participants received a "good" fitness rating) impacted the ability to examine their relationships with food proximity.

Base food consumption and BMI and PRT score

It was hypothesized that greater frequency of base food consumption would be associated with higher BMI and PRT score, which was not supported. Further, BMI and PRT score did not differ by type of food outlet (e.g., frequency of dining hall food vs. fast food consumption) by total eating out frequency (i.e., both during and outside of work), by frequency of eating food brought in by coworkers, or by vending machine/snack shack consumption frequency. Further, no associations were found between diet quality (as measured by the Block food screener) and BMI or fitness. Taken together, these findings

suggest that type of food eaten is not associated with weight or fitness, which is counter to a number of research studies (Binkley et al., 2000; Bowman & Vinyard, 2004; Jeffery et al., 2006; McCrory et al., 1999; Pereira et al., 2005), although not all of them (French et al., 2001; Duffy et al., 2007; Kant, 2000).

There are a number of possible explanations for this null finding. For example, this study did not directly assess the types of foods eaten from base food outlets or the amount of food eaten (i.e., portion size). To examine the possibility of food type in relation to BMI and PRT score, a fast food frequency index was created by calculating the sum of the number of times that personnel reported eating food from fast food outlets both on and off base in the last seven days. Fast food consumption frequency was not associated with BMI. However, fast food consumption frequency was positively associated with total fat consumption, $r_s = .38$, $p < .001$, saturated fat consumption, $r_s = .36$, $p < .001$, and cholesterol intake, $r_s = .38$, $p < .001$. Fast food consumption frequency also was negatively associated with fruit and vegetable intake, $r_s = -.22$, $p = .003$. These associations between greater fast food consumption and poorer diet quality are consistent with previous research (e.g., Jeffery et al., 2006) and suggest that greater fast food intake across both work and home environments may be negatively influencing diet quality, which could ultimately negatively impact health and fitness over time. Indeed, a negative association between fast food consumption frequency and PRT score was found, $r_s = -.131$, p (one-tailed) = .042; however, it did not remain significant when adjusting for covariates in an MRC analysis, which may be a result of a combination of the insensitivity of the measure (e.g., not assessing specific foods consumed) and demographic factors. We also did not specifically assess frequency of consumption of

caloric beverages, such as soda, lattes, and alcohol in the current study. Given the large amount of calories and sugar in certain beverages (Vartanian et al., 2007), it is possible that differential consumption in beverages and portion sizes of foods and beverages could account for the lack of relationship found between frequency of food consumption and both BMI and fitness in the current study. Further, the current study included both meals and snacks (as opposed to only meals), which may have been less sensitive of a measure of food consumption than separate measures of meals, snacks, and beverages.

Given that BMI is not a direct measure of body composition (i.e., body fat percentage and muscle mass), it could be that frequency of base food consumption is associated with greater body fat percentage, as opposed to body mass, per se. Further, it is possible that personnel who have a higher BMI or lower fitness level may modify their eating habits (i.e., decrease their base food consumption frequency or select healthier food options) in order to maintain or attain fitness standards. In support of this possibility, obese participants in the current study (n = 36; M = 4.24, SD = 4.91) reported eating food from base food outlets less often than normal weight participants (n = 52; M = 5.82, SD = 4.68; U = 600.50, p = .03, r = -.24), although possibly not enough to tip the positive energy balance in order to lose weight. It is also possible that military personnel compensate for episodes of greater food intake through exercise, given the pressures to adhere to fitness standards.

It is possible that measurement error may explain the lack of association between base food consumption frequency and BMI and PRT score. The 7-day recall may not be reflective of the average base food consumption frequency over time. Further, the 7-day recall may not have captured the eating habits of personnel who eat food from food

outlets on a less frequent basis (e.g., once or twice a month). Additionally, as mentioned above, relatively limited variance in outcome measures (i.e., the majority of the sample was overweight, received a "good" fitness level (PRT score between 75 and 89.9), and reported eating at base food outlets one or more times in the last 7 days) may have impacted the ability to examine the associations between base food consumption and BMI/fitness.

Discussion of Aim 2 Results

Research investigating the role of the food environment in overweight and obesity has begun to recognize that aside from objective measures of the food environment, it is important to examine the role of perception in eating behavior. Therefore, the purpose of Aim 2 in the current study was to examine associations between perceived aspects of the base food environment and eating behavior.

Perceived food proximity and eating behavior

It was hypothesized that personnel who perceived food outlets as being located closer to where they work would report eating food from them more often than personnel who perceived food outlets as being father away from where they work. Although this hypothesis was not supported when examining base food consumption from all base food outlets, it was supported when examining base food consumption from food outlets closest to participants in the close proximity group. One possible reason for the discrepancy is that the question required personnel to consider an "overall" rating of workplace proximity to base food outlets as opposed to rating workplace proximity to specific food outlets. Again, the proximity rating for the far proximity group may have been clouded by the fact that several food outlets are close to where they work (i.e., 18%

of far proximity group participants rated food outlets as relatively close (ratings of 1 or 2) to where they work; 5% of far proximity group participants rated food outlets as "very close to where I work" (rating of 1). Alternatively, personnel may have made their rating based on the relatively small size of the base (i.e., food outlets on base are not perceived as that far away regardless of where personnel work on base) or their personal experiences (e.g., how close food outlets are from their places of work or residence currently or in the past). The finding of a moderate correlation (as opposed to a strong correlation) between perceived and objective food proximity adds support to the idea that the perceived rating of workplace proximity may have been influenced by other factors.

Perceived nutritional value, convenience, taste, and cost

It was hypothesized that greater perceived nutritional value, greater perceived convenience, greater perceived tastiness, and lower perceived cost of food from base food outlets would be associated with base food consumption frequency. Although there was a trend for greater perceived nutritional value to be associated with base food consumption frequency, it was not statistically significant. No significant associations were found between base food consumption frequency and perceived convenience, taste, or cost. Once again, it is possible that having to use an "overall rating" for perceived factors across all base food outlets may have influenced these null findings (e.g., some food outlets may have higher perceived convenience than others; for example, the dining halls may have greater perceived nutritional value than other fast food outlets). It is also possible that personnel may have based their ratings on the specific food outlets they tended to eat food from as opposed to considering food from all food outlets when making their rating.

Study Implications

The study results suggest that workplace proximity to base food outlets may be influencing in eating behavior among military personnel, particularly among men. Given the cross-sectional design and predominantly enlisted, overweight, Caucasian male sample of Air Force personnel stationed at a single military installation in the Washington, D.C. area, it is important to replicate these findings using prospective studies at multiple military installations and samples that are more representative of current military demographics and balanced with regard to key demographic characteristics (e.g., gender, marital status) in order to enhance the confidence of these findings.

The study findings suggest that military personnel report eating out frequently, both on and off base. Total base food consumption frequency among study participants in the past 7 days (including food outlets, dining halls, vending machines, and snack shacks) averaged 8.77 (*SD* = 7.52). In the current sample, the number of times they ate non-home food both during and outside of work and both on and off base in the last 7 days totaled 16.06 (*SD* = 8.33). Based on the current sample, military personnel obtain 51.47% of their away-from-home foods from base food outlets (39.65% if dining halls are excluded). Although the base food environment may not be causing overweight or lower fitness among military personnel, base leadership appears to have an opportunity to be part of the solution for helping promote healthy eating habits among military personnel, which may have a positive impact on weight and fitness over time.

Swinburn and Egger (2002) posit that all corners of the Epidemiological Triad (host, vectors, and environment) must be addressed simultaneously in order to reverse the

increasing prevalence of obesity. For the most part, the Air Force has focused on the host corner of the triad (education, behavioral interventions, and medical interventions) through the Healthy Living Workshop, Body Composition Improvement Program, dieticians, exercise physiologists, classes at the Health and Wellness Center, annual Physical Health Assessments, and bariatric surgery. However, the vector corner of the triad (e.g., energy density of foods, portion size) and environmental corner of the triad (physical environment, economic environment, policy, sociocultural factors, and expertise) have received less attention in the Air Force. Below is a discussion of some possible interventions that may be implemented on military installations at unit, services, and leadership levels, with a focus on targeting the vector and environmental corners of the epidemiological obesity triad (Swinburn & Egger, 2002).

Unit level recommendations

Personnel appear to be exercising regularly, with 87% of study participants meeting ACSM guidelines for physical activity (ACSM, 2007). This suggests that commanders are doing a good job of encouraging their personnel to exercise. Therefore, it appears that strategies that focus on improving the other component of energy balance (i.e., diet quality) may be beneficial. After all, 87% and 85% of participants in the current study have a diet that exceeds the daily recommended intake of 65 grams of total fat and 20 grams of saturated fat, respectively (Netrition, 2009), and 55% of the sample exceeded the daily recommended cholesterol intake of 300 mg (Netrition, 2009), which puts personnel at risk of overweight and other health consequences over time. In fact, greater consumption of fat, saturated fat, and cholesterol were all associated with lower physical fitness (i.e., lower PRT scores) in the current study. Flight and squadron

commanders might consider implementing policies requiring healthy menu items at work functions or healthy snack options available in worksite snack areas (SYE, 2007). Co-workers may encourage one another to bring healthy snacks to share and have healthy potluck meals (SYE, 2007). Based on data from the current study, personnel who work in buildings farther away from base food outlets (i.e., units on the East side of base) may particularly benefit from increasing healthy food options in unit snack shacks and work buildings, given that these personnel reported eating food from their work building an average of 3.6 times in the last 7 days. Airmen who are in charge of unit snack shacks could poll unit personnel to assess the type of healthy options they would like available. The Healthy Snacks POC Guide may be a good resource regarding healthy options (SYE, 2004; SYE 2007). A research-based assessment tool that may assist in improving the healthfulness of the unit snack shacks is the Shape Your Environment Your Weigh tool developed by the Air Force Medical Service (D. Whelan, personal communication, May 11, 2007). This tool includes definitions of healthy snacks, recommended percentages of healthy snack options, and pricing guidance to help encourage the purchase of these healthier food options (SYE, 2007). Additionally, commanders can help ensure that units are equipped with refrigerators, freezers, microwaves and an employee eating area to encourage personnel to bring in food from home, which tend to be lower in calories, fat, and portion size (SYE, 2007). Ideas for healthy snack and meal options could be shared in Population Health Working Group and Integrated Delivery System meetings (SYE, 2007).

Services level recommendations

Services has focused on modifying dining hall menu options and preparing dining hall foods in healthier ways in recent years, which is an excellent step in the right direction. Further progress may be made healthy food preparation by having the cooks consult with nutritional medicine or a dietician, which is a strategy that has been used in the past at both the Air Force level and individual bases/work buildings (Heetderks-Cox, 2008). Consultation with an executive chef out in the community may help maintain good taste when increasing the nutritional value of food by using healthier flavoring (J. Heetderks-Cox, personal communication, December 11, 2008), particularly given that study personnel rated taste as the most important factor in food selection, which is also supported by previous research (Glanz et al., 1998). Given that 67.4% of the sample in the current study is not meeting the daily recommended serving or 5 servings of fruits and vegetables a day, adding a salad bar or healthy and convenient “grab ‘n go” items (e.g., pre-made salads, cut fruit) to the food court may be beneficial (J. Heetderks-Cox, personal communication, December 24, 2008). At Andrews AFB, the base club currently offers a lunch buffet. Although it contains some healthy items (salad, fruit, baked chicken), the cost of the buffet (about $10) arguably encourages people to eat larger portions in order to get their “money’s worth.” The base club might consider adding healthy and less expensive grab ‘n go or carry-out (e.g., one to-go plate) alternatives to the buffet. Increasing the accessibility of healthy food options on base also might include providing call-ahead ordering or delivery for pre-selected healthy alternatives, such as fresh sandwiches and salads (Webber, personal communication, April 2008).

Leadership level recommendations

Base leadership could collaborate with AAFES and Services to encourage vendors to promote the healthy options on their menus (SYE, 2007). One way of doing this might be for vendors to offer a "Special of the Day" that is higher in nutritional value and lower in cost. When seeking out new vendors in the future, base leadership might contract with vendors who: have a number of healthy options on their menu, are willing to offer price incentives for purchasing healthy items (i.e., are willing to negotiate on the price of healthy food items), are willing to offer healthier "default" combos (e.g., offer fruit or side salad instead of fries or chips), and/or are willing to increase prices for less healthy options relative to healthy options (e.g., pay more for fries than a fruit side).

Currently, installation commanders have the authorization to fund all food service equipment and supplies (Department of the Air Force, 2005). One recommendation for installation commanders to consider is investing money in purchasing equipment, such as combi ovens, that allow for healthier food preparation (e.g., healthier frying with 1/3 of the fat content compared to deep fat fryers) while maintaining ideal taste, texture, and appearance (Heetderks-Cox, 2008). In the current sample, 81.3% of the study sample reported eating French fries or fried potatoes one or more times in the past week. If these personnel ate fries prepared in combi ovens instead of a deep fat fryers and changed nothing else in their eating habits, they would ingest 10,920 fewer calories, or prevent a 3-pound weight gain, per year (based on a 4 oz potion size; Heetderks-Cox, 2008). Similarly, over 50% of the study sample reported eating French fries 2 or more times in the past week, and could ingest 21,840 fewer calories, or prevent a 6-pound weight gain per year if those French fries were prepared in Combi ovens, based on a 4 oz portion size.

Although nearly all of study participants (97.8%) reported passing their annual PRT test and may be classified as "successful" at meeting fitness standards, 54% of the sample reported gaining weight since they have been stationed at Andrews AFB, and the mean weight change per year (since stationed at Andrews AFB) in the current sample was a weight gain of 4.01 lbs (*SD* = 14.67). Therefore, the majority of participants are at risk of gaining weight, which could decrease fitness level and affect mission readiness over time. Further, greater fast food consumption was associated with lower physical fitness (i.e., lower PRT scores). The use of Combi ovens could help prevent annual weight gain and even promote weight maintenance or weight loss in the majority of the current sample.

All of the environmental changes described above should be test-piloted at single flights, buildings, squadrons, or bases to examine feasibility and cost-effectiveness prior to dissemination at the MAJCOM or Air Force level. Examination of cash receipts and profits (i.e., prior to, during, and after the test pilot) could track trends in healthy food purchases and overall sales over time in order to examine the effectiveness of these interventions. It should be noted that even small changes in the food environment can have an impact on a population (SYE, 2007).

Price incentives

Nearly 77.0% of participants rated low cost as a "moderately important" or "very important" factor to consider when deciding where to get their food on base. Therefore, it is important to find a way to increase the availability of healthy food options without increasing the price any more than necessary. Several food environment interventions shown that manipulating food prices can be a powerful tool for changing eating behavior while still maintaining a profit. For example, French and colleagues offered price

reductions on lower fat items in vending machines at 12 worksites and 12 high schools in Minnesota (French, Jeffrey, Story, Breitlow, Baxter, Hannan, et al., 2001). The researchers found that reductions of 10%, 25%, and 50% led to increased snack sales of 9%, 39%, and 93%, respectively, with an overall increase and snack volume increased while maintaining monthly profits (French Jeffrey, Story, Breitlow, et al., 2001). Another study using a similar technique of 50-cent reductions in fresh fruit and vegetables in secondary school cafeterias found that fresh fruit sales increased 4-fold and vegetable sales increased 2-fold (French, Story, Jeffrey, et al., 1997). Horgen and Brownell (2002) found even lower price reductions (i.e., 20-30%) on menu items in a family restaurant to be helpful in boosting sales. In addition to lowering prices of healthier options, vendors could simultaneously increase the prices of less healthy options in order to maintain and possibly increase profits (Hannan, French, Story, & Fulkerson, 2000; SYE, 2007). According to data from the present study, the majority of participants reported eating food from base food outlets (86.7%) and unit snack shacks (62.5%) one or more times in the past week. A much smaller percentage of personnel (25.1%) reported eating food from vending machines one or more times in the past week. Based on the relevance and changeability factors of the Analysis Grid for Environments Linked to Obesity (ANGELO) framework, which is a tool for prioritizing environmental interventions aimed at reducing overweight and obesity (Swinburn, Egger, & Raza, 1999), it appears that implementing price incentives in base food outlets and unit snack shacks, respectively, may have the largest impact on eating behavior among Air Force personnel.

Nutritional labeling

Another way of promoting healthy food options that has been used is the use of nutritional labeling or health messages. However, there has been some research suggesting that health message interventions may backfire. A study by Sproul and colleagues examined the effectiveness of nutritional labeling on purchases of targeted healthy food options in an Army cafeteria (Sproul, Canter, & Schmidt, 2003). Nutritional labeling included a 3 x 5 inch card that included a promotional symbol, calorie fat, and cholesterol information, and a promotional slogan ("It's a sure sign you're eating better"). The study sample consisted of primarily enlisted Army men, and the majority of respondents (79%) reported that the promotional materials did not influence their meal selection. A civilian study by Horgen and Brownell (2002) comparing the influence of health messages, price incentives (i.e., 20-30% price reduction for healthy items), and their combination on purchase of health food items in a delicatessen-style restaurant found that price incentives alone was associated with the greatest increase in purchases of healthy items relative to control items. Therefore, it may be more effective to use price incentives for healthy food options and use neutral slogans free of health messages (e.g., "Special of the Day") for promoting the purchase of healthy food options.

Healthy Living Program

One interesting finding in this study was the relatively high average frequency of eating out among study participants despite the fact that nearly 25% of the sample reported they were currently dieting to lose weight. This finding provides valuable information regarding understanding where people are regarding their readiness for eating behavior change. Currently, the Healthy Living Program emphasizes the

importance of healthy eating, including watching portion size, eating 5 fruits of vegetables per day, and decreasing eating out frequency (U.S. Department of the Air Force, 2006). This suggests a possible mismatch between the aims of the Healthy Living Workshop (i.e., to decrease eating out behavior) and where personnel are at (i.e., eating out 5-8 times per week and not meeting the daily recommended values for fruit and vegetable intake). From a motivational interviewing perspective (Miller & Rollnick, 2002), it is important to "meet people where they are at" when engaging in discussion of lifestyle change. The data from the current study as well as other studies and personal communications suggests that military personnel eat out frequently and are frequently TDY or in deployed settings, where they may not have the option of making a home-cooked meal, and so this is where interventions should begin. Given that the Healthy Living Program already uses motivational interviewing as the basis for their intervention, it would not be difficult to incorporate fast food nutrition information in the participant manual allow for more verbal discussion around how to eat healthy "on the go" as opposed to taking the more traditional focus on decreasing eating out frequency and increasing the frequency of eating home-cooked meals per se. In particular, discussions around how many miles a person would have to run to burn off the calories from various fast food items may be illuminating and help personnel identify the "biggest bang for the buck" when deciding on where to make substitutions when eating out (e.g., diet soda or water instead of regular soda; fruit instead of fries).

Limitations

This study has several limitations. One limitation of this study is the focus on a single environment: the work environment. Other environments of influence on eating

behavior and weight may include one's home environment and commuting environment (Papas et al., 2007). Nonetheless, one's work environment may impact eating behavior and weight status. After all, the average person spends at least 36% of weekly awake time at work (based on a 40 hour work week, working five days per week, and sleeping eight hours per night), which represents 1-2 meals per day (or 33-66% of kcal) consumed during work hours. For military personnel, who may be working 12-hour days or working more than five days a week, this percentage may be more than 50% of awake time, and as much as 2-3 meals per day (or 66-100% of kcal) consumed during work hours. Given these figures and the large percentage of meals and snacks eaten by military personnel on base, it seems plausible that the base food environment is contributing to overweight among military personnel.

In recognition of the possible influence of other environments on eating behavior, questions regarding off-base eating out frequency were included in the current study. In addition to the non-significant association between BMI and frequency of food consumption from base food outlets, the relationship between total eating out frequency (both number and percent of food eaten out and both during and outside of work) and BMI was not significant, which is contrary to former studies. However, it is important to note that only a one-week recall was used, which may not reliably capture people's general eating habits over time. Further, portion size and specific foods eaten were not assessed in this study. Alternatively, it is possible that 1) eating out behavior is a marker of BMI (i.e., people with lower BMI tend to eat out more often than people with a higher BMI), or 2) BMI influences eating out behavior among military personnel as opposed to the other way around (i.e., in response to weight gain, personnel may decrease eating out

frequency or increase exercise frequency or intensity in order to maintain fitness standards).

It is possible that in addition to base food outlets, the unit environment may also influence eating habits and weight among military personnel. For this reason, the survey included a question regarding the frequency in which personnel consumed food from within their work building (e.g., vending machines, snack shacks, food brought in by co-workers) in the last seven days. However, once again, the relationship between work building food frequency and BMI was not found to be significant.

Another limitation of this study is the assessment of frequency of base food consumption. No validated measure of frequency of fast food consumption exists to date. Most studies in the literature have assessed frequency of fast food consumption using a single question (e.g., "How many times in the past week have you eaten fast food e.g., from McDonald's, Burger King, Hardee's, etc.?"; French et al., 2000; Pereira et al., 2005). Two studies that used this method found a relation between the frequency of fast food consumption and foods endorsed in the food frequency questionnaire, supporting the use of this method for assessing fast food consumption (French et al., 2000; Pereira et al., 2005). This question was slightly modified in the current study to assess frequency of base food consumption in a way that is specifically tailored to the Andrews AFB food environment. Specifically, each base food outlet was listed individually in order increase the accuracy and reliability of responses and to permit examination of differences in frequency of food consumption by workplace proximity.

Another limitation of the current study is that the short form of the IPAQ may underestimate physical activity levels compared to the long form of the IPAQ (Hallal &

Victora, 2004). However, this study was not interested in whether or not people are meeting daily recommended levels of physical activity. Instead, this study was interested in comparing activity levels across individuals. If the levels are underestimated, it was expected that they would be systematically low. Further, the short form of the IPAQ was chosen in order to decrease participant burden. Unfortunately, a number of participants had incomplete physical activity data as a result of answering “don’t know/not sure” on one or more of the time spent engaging in vigorous, moderate, or walking activities. The use of the mean substitution may have further impacted the validity of the measure.

Another limitation is that this study did not assess environmental factors that may influence physical activity and exercise (e.g., presence of footpaths, sidewalks, and well-designed public open spaces), which also could influence BMI (Giles-Corti et al., 2005; Leslie et al., 2007). Instead, the focus in the current study was on the food environment, which is understudied compared to the physical activity environment. However, exercise and physical activity were assessed in this study. Further, military personnel have free access to exercise facilities on base, which helps hold the physical environment factor more constant in the work environment compared to that in the civilian sector.

Future Directions

Future studies aimed to replicate and extend these findings could improve on the methodological limitations in several ways. First, measures of actual food and beverage consumption should be used in addition to frequency measures, which may include a 24-hour recall (or recall of foods and beverages last consumed at base food outlet), weighing foods at the cash register, and/or through cash receipts. Frequency measures, if used, might include a measure of both last 7 days and usual frequency in both a typical week

and a typical month in order to attempt to enhance the reliability and representativeness of the data and decrease the possibility of floor effects. Measures of perceived aspects of food may be tied to a specific food outlet(s) in order to get a better sense of why people eat where they eat. Other definitions of the food proximity construct should also be explored, both in terms of distance (e.g., 200, 400 meters) and in terms of definition (e.g., distance to nearest outlet, number of outlets in X meters, average distance to three closest outlets, and food outlet density (Apparicio et al., 2007; Maddock, 2007). Also, including people's home zip code may add valuable information in order to begin to examine relationships between proximity to food outlets and food consumption in both home and work environments. Of course, ensuring that comparison groups are comparable on key variables (e.g., gender, marital status, AFSC) also would be important. Using a continuous measure of proximity also may increase the sensitivity and power to detect differences in away-from-home food consumption.

Future studies may examine how workplace proximity to food outlets may generalize to other Air Force bases, different branches of service, and deployed settings. Longitudinal studies that examine eating habits, BMI, and PRT scores over time also may be beneficial. Extreme environments (e.g., basic military training and newly established deployed settings) may promote healthy weight and fitness among military personnel (e.g., limited food options outside of dining halls, little else to do with spare time other than exercise). In contrast, more established deployed environments on bases may have multiple food outlets on them, which could promote weight gain.

However, given that military personnel spend a considerable amount of time stateside, learning about how their home, work, commute, and TDY environments

influence their eating and exercise habits as well as BMI and fitness may help identify how to effectively intervene. Conducting focus groups may help identify risk factors for weight gain among military personnel (e.g., nightshifts, long work hours, little time for lunch breaks or exercise during the duty day, frequent travel, long commutes) as well as elicit their ideas about how to modify the base food environment in ways that would encourage them to make healthier food choices.

Pilot studies examining the effect of environmental changes on eating behavior, BMI, and fitness among military personnel would be important to help inform the direction that leadership takes with respect to modifying the base food environment on a larger scale to promote healthy weight and fitness. These pilot studies may involve using one or more of the recommendations discussed above. For example, the POC of a unit snack shack might 1) poll their unit members for preferences regarding which healthy food options to add to their snack shack (using the Healthy Snacks POC guide, SYE, 2004), 2) add the most popular healthy options to a unit snack shack using the price incentives discussed in the Shape Your Environment Your Weigh tool (SYE, 2007), and 3) track food purchases prior to, during, and after the intervention, including changes in profit over time.

Prospective, longitudinal studies are needed to elucidate the reason behind the finding of a lack of association between eating out behavior and BMI and PRT score. It is possible that people with a lower BMI are eating out more often because they can (i.e., they are able to meet fitness standards). This possibility is supported by the trend for obese participants to eat food from base outlets less often than overweight participants, who in turn eat food from base food outlets less often than normal weight participants in

the current study. Over time, however, individuals may gain weight and then begin to eat out less in order to maintain or meet fitness standards. If indeed this is the trend among military personnel, then a primary prevention approach (i.e., population health approach, such as modifying the base food environment) can help prevent weight gain among military personnel.

Additionally, it remains unknown how the results of the current study may generalize to a civilian population. Focusing on a single military installation provides a natural boundary that is unusual, but not unheard of in the civilian sector. For example, neo-traditional neighborhood design communities that are compact communities designed to encourage walking and biking and destinations that are close to home and work (e.g., King Farm in Rockville, MD) that are meant to be self-sustaining communities have natural boundaries and are increasing in popularity (U.S. Department of Transportation, 2007). An examination of food proximity and eating behavior and BMI may be worth examining in these types of communities. However, it is important to note that selection bias may play a role in civilian communities, as people have more choice about where to live and work, meaning that some people who like to go out to eat often may select a residence that is closer to various restaurants than people who tend to eat home-cooked meals.

A final thing to note is the clinical significance of food proximity with respect to eating behavior. Although closer workplace proximity to base food outlets was associated with greater base food consumption frequency, it only explained 3.4% of the variance in eating behavior (2.0% of the variance in eating behavior after adjusting for covariates), suggesting that other factors may be important to examine. Some qualitative

research (e.g., focus groups) may assist in identifying additional factors that may influence eating behavior among military personnel (e.g., parking difficulties, long lines, eating atmosphere). Additionally, the contrasting distances (< 1 mile vs. > 2 miles) to food outlets in the current study may not have been sufficient to differentially influence eating behavior. Additional measures for food proximity, food availability, and eating out behavior should be developed and used in future research to better understand how the food environment may influence eating behavior, weight, and fitness among both military and civilian populations.

Table 2

Sample Demographics

	Entire Sample (*N* = 192)	Close Proximity Group (*n* = 99)	Far Proximity Group (*n* = 89)
	n (%)	*n* (%)	*n* (%)
Gender			
Male	154 (80.6)	87 (87.9)	63 (71.6)
Female	37 (19.4)	12 (12.1)	25 (28.4)
Race/Ethnicity			
Caucasian	111 (58.4)	57 (58.2)	52 (59.1)
African American	45 (23.7)	24 (24.5)	19 (21.6)
Hispanic	19 (10.0)	11 (11.2)	8 (9.1)
Asian	8 (4.2)	4 (4.1)	4 (4.5)
Other	7 (3.7)	2 (2.0)	5 (5.7)
Education			
Grade 12 or GED	22 (11.5)	12 (12.1)	10 (11.2)
Some college or technical school	129 (67.2)	68 (68.7)	58 (65.2)
Bachelor's degree	21 (10.9)	9 (9.1)	11 (12.4)
Some graduate/advanced degree	20 (10.4)	10 (10.1)	10 (11.2)
Marital Status			
Never married	59 (30.9)	35 (35.4)	23 (26.1)
Married	106 (55.5)	48 (48.5)	55 (62.5)
Other	26 (13.6)	16 (16.2)	10 (11.4)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Age	31.0 (8.9)	30.0 (8.1)	32.1 (9.1)
BMI (kg/m^2)	27.1 (3.5)	27.2 (3.5)	26.9 (3.5)

Table 3

Sample Military Characteristics

	Entire Sample (*N* = 192)	Close Proximity Group (*n* = 99)	Far Proximity Group (*n* = 89)
	n (%)	*n* (%)	*n* (%)
Rank			
Airmen (E-1 to E-4)	61 (32.1)	32 (32.3)	26 (29.9)
Junior Non-Commissioned Officers (E-5 to E-6)	68 (35.8)	40 (40.4)	28 (32.2)
Senior Non-Commissioned Officers (E-7 to E-9)	43 (22.6)	21 (21.3)	22 (25.3)
Company Grade Officers (O-1 to O-3)	7 (3.7)	4 (4.0)	3 (3.4)
Field Grade Officers (O-4 to O-6)	11 (5.8)	2 (2.0)	8 (9.2)
Military Job/Occupation			
Communications/Intelligence	34 (17.7)	30 (30.3)	4 (4.5)
Administration	19 (9.9)	3 (3.0)	15 (16.9)
Logistics	18 (9.4)	1 (1.0)	17 (19.1)
Engineering/Maintenance	44 (22.9)	16 (16.2)	28 (31.5)
Security Forces	42 (21.9)	39 (39.4)	0 (0.0)
Other	35 (18.2)	10 (10.1)	25 (28.0)
Residence			
Dormitory	24 (12.6)	14 (14.1)	9 (10.1)
Base housing	28 (14.7)	15 (15.2)	12 (13.5)
Off base	139 (72.8)	70 (70.7)	68 (76.4)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Years of military service (TIS)	10.8 (8.2)	10.2 (7.7)	11.4 (8.4)
Time on station (TOS)	3.6 (5.1)	3.4 (4.9)	3.9 (5.4)
Physical Readiness Test Score	85.2 (7.2)	84.5 (8.9)	86.0 (7.0)

Table 4

Sample Health Characteristics

	Entire Sample (*N* = 192)	Close Proximity Group (*n* = 99)	Far Proximity Group (*n* = 89)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Where food was obtained (#)			
Base food outlets during work	5.2 (4.7)	5.5 (5.0)	4.8 (4.4)
Work building during work	2.8 (4.4)	2.2 (3.5)	3.6 (5.2)
Food from home at work	4.7 (5.6)	4.8 (5.8)	4.4 (4.8)
Lifestyle Factors			
Daily fruit/vegetables (#)	4.4 (1.9)	4.3 (1.8)	4.4 (2.0)
Daily saturated fat intake (gms)	30.1 (8.7)	30.7 (8.4)	29.5 (9.1)
Daily cholesterol intake (gms)	312.3 (81.6)	317.8 (81.1)	305.7 (83.6)
Frequency of eating out	16.1 (8.4)	16.3 (8.7)	15.9 (8.1)
Average daily PA minutes	128.53 (161.0)	154.0 (193.0)	101.3 (115.0)
BMI Category (kg/m^2)	*n* (%)	*n* (%)	*n* (%)
Normal weight (18.5-24.9)	52 (27.1)	24 (24.2)	27 (30.3)
Overweight (25.0-29.9)	104 (54.2)	54 (54.5)	47 (52.8)
Obese (30.0 or greater)	36 (18.7)	21 (21.2)	15 (16.9)
Weight change while on station			
Gained weight	105 (54.7)	57 (57.6)	46 (52.8)
Lost weight	28 (14.6)	18 (18.2)	8 (9.2)
Maintained weight	57 (29.7)	24 (24.2)	33 (38.0)
Currently smoke	51 (26.8)	29 (29.2)	21 (23.6)
Currently dieting to lose weight	47 (25.0)	27 (27.3)	19 (22.4)
Any health condition	21 (11.0)	8 (8.1)	12 (13.6)
Any dietary restrictions	14 (7.3)	5 (5.1)	8 (9.1)

Table 5

Regression Analysis for Food Proximity Predicting Base Food Consumption Frequency (N = 180)

Variable	*B*	*SE B*	β
Proximity Group	0.10	0.04	.18

Note. R^2 = ..034; *p* = .014.

Table 6

Summary of Hierarchical Regression Analysis for Variables Predicting Base Food Consumption Frequency (N = 177)

Variable	*B*	*SE B*	β
Step 1			
Gender	0.047	0.048	.072
Age	-0.003	0.002	-.092
Marital Status	-0.063	0.042	-.119
Live Off Base vs. Dorm	0.253	0.069	.305**
Live Off Base vs. Base Housing	-0.044	0.054	-.060
# Work Hours	0.001	0.001	.078
Step 2			
Proximity Group	0.077	0.038	.147*

Note. R^2 = .203 for Step 1; ΔR^2 = .019 for Step 2 (*ps* < .05). *p < .05. **p < .01.

Table 7

Summary of Hierarchical Regression Analysis for Variables Predicting Base Food Consumption Frequency with Gender Excluded (N = 177)

Variable	*B*	*SE B*	β
Step 1			
Age	-0.003	0.002	-.091
Marital Status	-0.071	0.042	-.134
Live Off Base vs. Dorm	0.241	0.068	.290**
Live Off Base vs. Base Housing	-0.050	0.053	-.068
# Work Hours	0.001	0.001	.067
Step 2			
Proximity Group	0.062	0.037	.118*

Note. R^2 = .199 for Step 1 (p < .001); ΔR^2 = .013 for Step 2 (*p* = .092). *p < .05. **p < .01.

Table 8

Summary of Hierarchical Regression Analysis for Proximity X Gender Interaction Predicting Base Food Consumption (N = 177)

Variable	*B*	*SE B*	β
Step 1			
Gender	0.047	0.048	.072
Age	-0.003	0.002	-.093
Marital Status	-0.043	0.042	-.119
Live Off Base vs. Dorm	0.241	0.068	.290**
Live Off Base vs. Base Housing	-0.050	0.053	-.068
# Work Hours	0.001	0.001	.077
Step 2			
Proximity Group	0.077	0.038	.147*
Step 3			
Proximity Group x Gender	-0.187	0.097	-.164

Note. R^2 = .203 for Step 1; ΔR^2 = .019 for Step 2 (*ps* < .05); ΔR^2 = .017 for Step 3 (*p* = .056).
*p < .05. **p < .01.

Table 9

Summary of Hierarchical Regression Analysis for Variables Predicting Base Food Consumption Frequency in Men Only (N = 142)

Variable	*B*	*SE B*	β
Step 1			
Age	-0.002	0.003	-.059
Marital Status	-0.104	0.048	-.189
Live Off Base vs. Dorm	0.261	0.073	.330**
Live Off Base vs. Base Housing	-0.041	0.055	-.058
# Work Hours	0.000	0.001	.008
Step 2			
Proximity Group	0.105	0.041	.193*

Note. R^2 = .251 for Step 1; ΔR^2 = .035 for Step 2 (*ps* < .05). *p < .05. **p < .01.

Table 10

Regression Analysis for Food Proximity Predicting Body Mass Index (N = 188)

Variable	*B*	*SE B*	β
Proximity Group	0.308	0.514	.044

Note. R^2 = ..002; *p* = .549.

Table 11

Summary of Hierarchical Regression Analysis for Food Proximity Predicting Body Mass Index (N = 185)

Variable	*B*	*SE B*	β
Step 1			
Gender	-2.240	0.660	-.252*
Age	0.084	0.034	.206**
African American vs. Caucasian	1.970	0.615	.237**
Hispanic vs. Caucasian	1.721	0.828	.149*
Asian vs. Caucasian	-2.179	1.224	-.126
Other Race vs. Caucasian	-0.695	1.398	-.038
Total Physical Activity METs	0.000	0.000	.031
Time on Station (Years)	-0.031	0.056	-.045
Step 2			
Proximity Group	-0.106	0.510	-.015

Note. R^2 = .165 for Step 1, p < .001; ΔR^2 = .0002 for Step 2, p = .835. *p < .05. **p < .01.

Table 12

Regression Analysis for Food Proximity Predicting Physical Readiness Test Score (N = 178)

Variable	*B*	*SE B*	β
Proximity Group	-0.005	0.005	-.076

Note. R^2 = .006; p = .315.

Table 13

Summary of Hierarchical Regression Analysis for Food Proximity Predicting Physical Readiness Test Score (N = 177)

Variable	*B*	*SE B*	β
Step 1			
BMI	-0.004	0.001	-.399**
Live Off Base vs. Dorm	0.010	0.010	.092
Live Off Base vs. Base Housing	-0.010	0.009	-.101
Married vs. Not Married	-0.000	0.006	-.005
Total Commute Time	-0.000	0.000	-.161
Time on Station (Years)	0.000	0.001	.001
Step 2			
Proximity Group	-0.006	0.005	-.080

Note. R^2 = .231 for Step 1, p < .001; ΔR^2 = .006 for Step 2, p = .256. **p < .01.

Table 14

Regression Analysis for Base Food Consumption Frequency Predicting Body Mass Index (N = 184)

Variable	*B*	*SE B*	β
Proximity Group	-0.096	0.054	-.130

Note. R^2 = ..017; p = .079.

Table 15

Summary of Hierarchical Regression Analysis for Base Food Consumption Predicting Body Mass Index (N = 180)

Variable	*B*	*SE B*	β
Step 1			
Gender	-2.025	0.677	-.229**
Age	0.082	0.034	.202*
African American vs. Caucasian	1.783	0.624	.216**
Hispanic vs. Caucasian	1.619	0.828	.144
Asian vs. Caucasian	-2.300	1.222	-.137
Other Race vs. Caucasian	-0.718	1.294	-.040
Physical Activity METs	0.000	0.000	.054
Time on Station (Years)	-0.025	0.063	-.033
Step 2			
Base Food Consumption Frequency	-0.100	0.059	-.135

Note. R^2 = .149 for Step 1, p < .001; ΔR^2 = .014 for Step 2, p = .091. *p < .05. **p < .01.

Table 16

Regression Analysis for Base Food Consumption Frequency Predicting Physical Readiness Test Score (N = 175)

Variable	*B*	*SE B*	β
Proximity Group	0.001	0.001	.122

Note. R^2 = .009; p = .109.

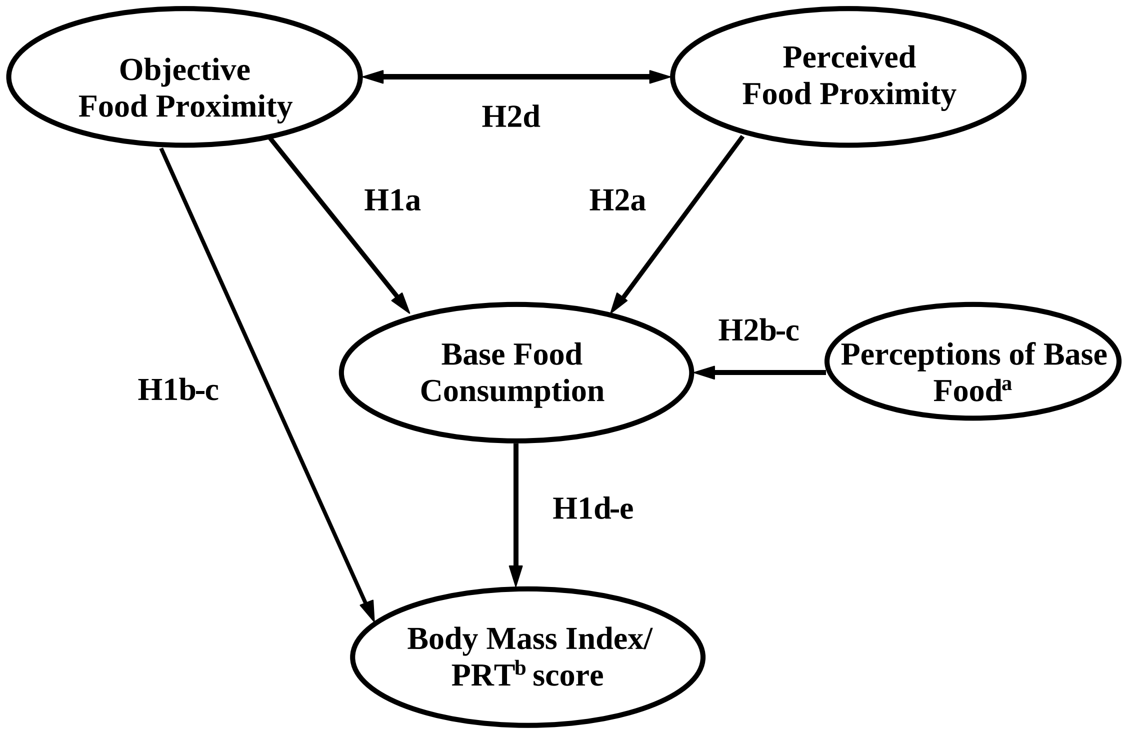
Table 17

Summary of Hierarchical Regression Analysis for Base Food Consumption Frequency Predicting Physical Readiness Test Score (N = 172)

Variable	*B*	*SE B*	β
Step 1			
BMI	-0.004	0.001	-.403**
Live Off Base vs. Dorm	0.009	0.010	.080
Live Off Base vs. Base Housing	-0.012	0.009	-.115
Married vs. Not Married	0.001	0.006	.018
Total Commute Time	-0.000	0.000	-.166
Time on Station (Years)	0.000	0.001	.011
Step 2			
Base Food Consumption Frequency	-0.000	0.001	-.006

Note. $R^2 = .221$ for Step 1, $p < .001$; $\Delta R^2 = .00002$ for Step 2, $p = .940$. *p < .05. **p < .01.

Figure 1. Study Model.



[a]Perceptions of base food = Proximity, convenience, cost.
[b]PRT = Physical readiness test.

Appendix A: Study Description for Commanders

The Role of Food Proximity in Eating Behavior and Body Mass Index Among Air Force Personnel

Principal Investigator: Crescent Seibert, M.S., USUHS Graduate Student

Research Study Background

Over half of active duty military personnel are either overweight or obese.[1,2] Compared to normal weight status, overweight status among military personnel is associated with greater health risk, lower health status, and lower physical fitness,[3] which compromise operational readiness and mission accomplishment. Whereas much research to date has examined individual factors associated with overweight (e.g., genetics, diet, and lack of exercise), the role of environmental factors has received less attention.[4] Environmental factors are clearly associated with eating behavior and overweight. Healthy foods are often more expensive, harder to obtain, and less convenient than less healthy foods. The purpose of the proposed study is to examine the role of objective and perceived environmental factors in eating behavior and body mass index among Air Force personnel.

Specific Aims of the Study

1. To examine the association between physical proximity to base food outlets and both frequency of base food consumption and body mass index.
2. To examine the association between perceived access to food (i.e., proximity, convenience, nutritional value, and cost) and frequency of base food consumption.

Study Methods

Participants will consist of 178 Air Force personnel stationed at Andrews AFB who work in buildings with different proximity to base food outlets. Participants will be assessed in groups of approximately 30-40 individuals at a location and time that is convenient for their units. Study procedures will consist of completing an anonymous survey and undergoing a height and weight assessment. The survey will assess individual eating habits, perceived aspects of the food environment (e.g., proximity to workplace, convenience, nutritional value, cost), and other factors associated with overweight (e.g., physical activity and exercise, off-base eating out frequency, lifestyle factors). The study procedures will take approximately 30-45 minutes. Participants will receive a letter of appreciation from the principal investigator as well as a written summary of the study results if they are interested. A written summary of the study results also will be provided to interested unit commanders and base leadership.

Importance and Potential Implications of the Study

This study will assist in understanding how food proximity and perceived aspects of the base food environment may influence eating behavior and body mass index among Air Force personnel. This understanding will help inform potential environmental interventions, such as improving the availability, convenience, nutritional value,

proximity, and affordability of healthy food options on base. These interventions may promote healthier food choices and consequently improve health and readiness of military personnel.

Note About Preventing Coercion

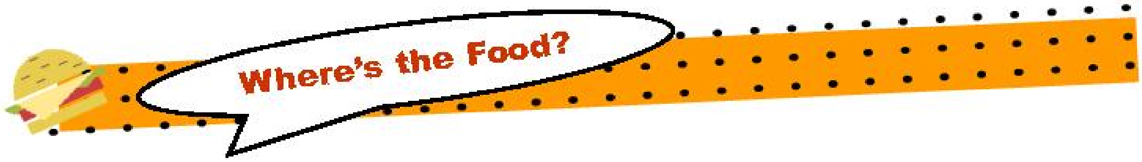
In order to prevent coercion, unit leadership (i.e., NCOICs and personnel E-7 and above, including all officers) may not be present or participate in the study at the same time as other unit personnel. Separate study flyers with a different date and time will be posted specifically for unit leadership.

If you have any questions about the study, feel free to contact the Principal Investigator, Crescent Seibert, at cseibert@usuhs.mil or 301-775-5341.

References

1. Bray, R. M., Rae Olmsted, K. L., Williams, J., Sanchez, R. P., & Hartzell, M. (2006). Progress toward healthy people 2000 objectives among U.S. military personnel. *Preventive Medicine*, *42*(5), 390-396.
2. National Quality Management Program (2003). *Prevalence of Obesity in the Direct Care System.* Retrieved September 4, 2005, from http://www.nqmp.info/ed/content/fact_fr.htm
3. Troumbley, P. F., Rinke, W. J., Burman, K. D., & Lenz, E. R. (1990). A comparison of the health risk, health status, self-motivation, psychological symptomatic distress, and physical fitness of overweight and normal-weight soldiers. *Military Medicine*, *155*, 424-429.
4. Merchant, A. T., Dehghan, M., Behnke-Cook, D., & Anand, S. S. (2007). Diet, physical activity, and adiposity in children in poor and rich neighbourhoods: a cross-sectional comparison. *Nutrition Journal*, *6*, 1.

Appendix B: Sample Study Advertisements



Food Proximity Research Study

WHO: Active duty or full-time Guard & Reserve Air Force personnel (ages 18 and older) currently stationed at Andrews AFB who meet all of the following criteria:

- **ranks E1-E6 who are not NCOICs**
- not currently on a medical waiver or profile that interferes with the ability to exercise
- work in Building 1535 (316th Headquarters)

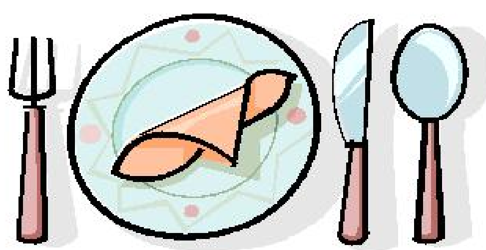
WHAT: We are looking for volunteers to participate in a research study on how proximity to food on base influences eating behavior and weight. Study procedures will take approximately 45 minutes and involve completing a 20-minute survey and a height and weight assessment.

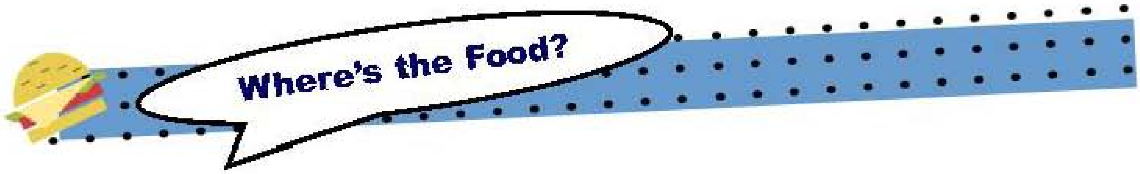
WHEN: DATE: TIME:

WHERE: BUILDING: ROOM:

To sign up, or for more information,

Call 301-775-5341





Food Proximity Research Study

WHO: Active duty or full-time Guard & Reserve Air Force personnel (ages 18 and older) currently stationed at Andrews AFB who meet all of the following criteria:

- **NCOICs or ranks E7 and above (including officers)**
- not currently on a medical waiver or profile that interferes with the ability to exercise
- work in Building 1535 (316th Headquarters)

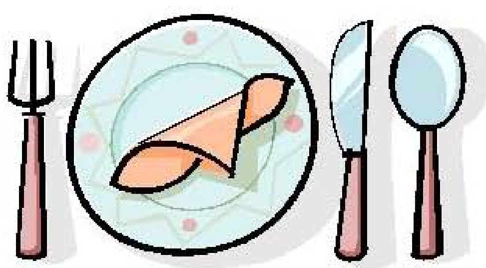
WHAT: We are looking for volunteers to participate in a research study on how proximity to food on base influences eating behavior and weight. Study procedures will take approximately 45 minutes and involve completing a 20-minute survey and a height and weight assessment.

WHEN: DATE: TIME:

WHERE: BUILDING: ROOM:

To sign up, or for more information,

Call 301-775-5341



Appendix C: Survey

Participant # ___ ___ ___

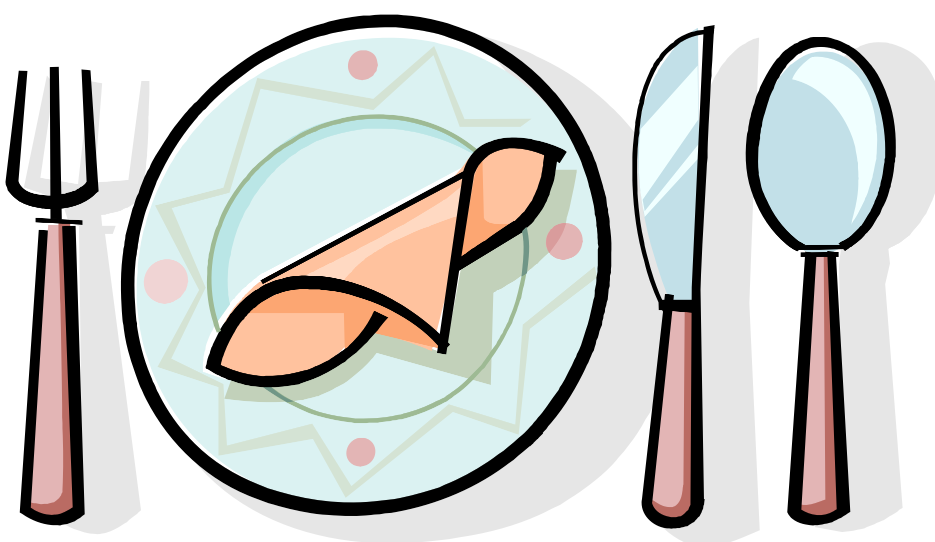
Dear Air Force Member,

The purpose of this survey is to learn about the eating habits of Air Force personnel, both in general and on base. Aside from asking about your eating habits, we will be asking you some questions about exercise and physical activity, work, lifestyle, and stress.

The survey will take approximately 20 minutes to complete. There are no right or wrong answers. If there is a question that makes you feel uncomfortable, you do not have to answer it. Your individual responses will remain confidential. An overall summary of the study results may be released to the public.

Sincerely,

Crescent A. Seibert, M.S.
Graduate Student
Department of Medical and Clinical Psychology
Uniformed Services University of the Health Sciences
Bethesda, MD 20814-4799



WHAT YOU EAT

First, we are going to ask you about how often you eat various types of foods. The purpose of these questions is to give us a general idea of people's eating habits over the past year or so.

Think about your eating habits over the past year or so. About how often do you eat each of the following foods? Remember breakfast, lunch, dinner, snacks, and eating out. Mark an '**X**' in one column for each food.

Fruits and Vegetables	Less than 1/WEEK	Once a WEEK	2-3 times a WEEK	4-6 times a WEEK	Once a DAY	2+ a DAY
Fruit juice, like orange, apple grape—fresh, frozen or canned (Not sodas or other drinks)						
How often do you eat any fruit, fresh or canned (not counting juice?)						
Vegetable juice, like tomato juice, V-8, carrot						
Green salad						
Potatoes, any kind, including baked, mashed or French fried						
Vegetable soup, or stew with vegetables						
Any vegetables, including string beans, peas, corn, broccoli or any other kind						

Think about your eating habits over the past year or so. About how often do you eat each of the following foods? Remember breakfast, lunch, dinner, snacks, and eating out. Mark an '**X**' in one column for each food. (*Please note that the frequencies in each column are different from the frequencies on the previous page*.)

Meats and Snacks	1/MONTH or less	2-3 times a MONTH	1-2 times a WEEK	3-4 times a WEEK	5+ times a WEEK
Hamburgers, ground beef, meat burritos, tacos					
Beef or pork, such as steaks, roasts, ribs, or in sandwiches					
Fried chicken					
Hot dogs, or Polish or Italian sausage					
Cold cuts, lunch meats, ham (not low-fat)					
Bacon or breakfast sausage					
Salad dressings (not low-fat)					
Margarine, butter or mayo on bread or potatoes					
Margarine, butter or oil in cooking					
Eggs (not Egg Beaters or just egg whites)					
Pizza					
Cheese, cheese spread (not low-fat)					
Whole milk					
French fries, fried potatoes					
Corn chips, potato chips, popcorn, crackers					
Doughnuts, pastries, cake, cookies (not low fat)					
Ice cream (not sherbet or non-fat)					

WHERE YOU GET YOUR FOOD

The next set of questions asks you about how often you have eaten food from different food outlets on base in the last 7 days.

1. How many times did you eat food from each of the following food outlets on base in the last 7 days? Include both meals and snacks. Do NOT include food brought to you from these locations from a co-worker.

___ BX Food Court
___ Base Club
___ Freedom Dining Hall (West side of base)
___ Commissary (NOT including commissary grocery shopping)
___ Church's Chicken
___ Burger King
___ Four Season's Store
___ Katmandu Kafé (in 316th HQ)
___ Hospital Cafeteria
___ Starbucks
___ Bowling Alley
___ Sports Page Café
___ Golf Course Clubhouse
___ Liberty Dining Hall (East side of base)
___ Denny's BBQ (East side of base)
___ Shoppette (East side of base)
___ Other (please specify): ___________________________

How many of the above times were snacks? ______

2. How many times did you eat food from each of the following food outlets on base in the last 7 days that was brought to you by a co-worker.

___ BX Food Court
___ Base Club
___ Freedom Dining Hall (West side of base)
___ Commissary (NOT including commissary grocery shopping)
___ Church's Chicken
___ Burger King
___ Four Season's Store
___ Katmandu Kafé (in 316th HQ)
___ Hospital Cafeteria
___ Starbucks
___ Bowling Alley
___ Sports Page Café
___ Golf Course Clubhouse
___ Liberty Dining Hall (East side of base)
___ Denny's BBQ (East side of base)
___ Shoppette (East side of base)
___ Other (please specify): ___________________________

3. How often did you use an automobile to get food from base food outlets in the last 7 days? (If you did not eat food from any base food outlets in the past week, leave this question blank.)

- ___ Never
- ___ A few times
- ___ Sometimes
- ___ Most of the time
- ___ All of the time

4. How many times did the season, weather, or temperature prevent you from going somewhere to get food on base in the last 7 days? ____times

5. How many times did you purchase food or beverages (not including water) in vending machines in your flight or building in the last 7 days? _____times

6. How many times did you eat food or snacks that were available in your flight or building in the last 7 days (e.g., flight snack shack, food brought in by your co-workers)? _____times

7. How many times did you bring your own meal(s) from home to work in the last 7 days? ____times

8. How many times did you bring your own snack(s) from home to work in the last 7 days? ____ times

BASE FOOD OUTLETS

The next few questions ask you to rate different aspects of food outlets on base.

9. In general, how **close** are the food outlets on base to where you work? Circle the appropriate number.

1	2	3	4	5	6
Very Close to where I work					Very far from where I work

10. <u>In general</u>, how **convenient** is it to obtain food from food outlets on base? Circle the appropriate number.

1	2	3	4	5	6
Very Convenient					Not Convenient

11. <u>In general</u>, how **affordable** is it to eat at food outlets on base? Circle the appropriate number.

1	2	3	4	5	6
Cheap					Expensive

12. In general, how would you rate the <u>overall</u> **nutritional value** of food from food outlets on base? Circle the appropriate number.

1	2	3	4	5	6
Not healthy					Very healthy

13. In general, how would you rate the <u>overall</u> **taste** of food from food outlets on base? Circle the appropriate number.

1	2	3	4	5	6
Not Tasty					Very Tasty

14. Now rate how <u>important</u> each of the following factors are to <u>you personally</u> when choosing where to get your food <u>on base</u> on a typical work day. Circle the appropriate number.

<u>Importance of closeness to workplace:</u>

1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

<u>Importance of convenience (little time and effort):</u>

1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

Importance of low cost:

1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

Importance of nutritional value:

1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

Importance of good taste:

1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

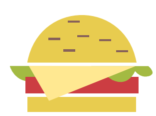
Importance of eating where my co-workers/friends eat:

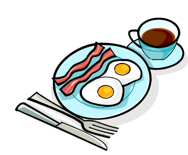
1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

Importance of closeness to where I run my errands on base (e.g., drycleaners, shopping, gas, bank):

1	2	3	4
Not at all Important	A little Important	Moderately Important	Very Important

OFF BASE AND HOME EATING





The next five questions ask you about how many times you have eaten food from locations off base in the last 7 days.

15. How many times did you eat food from fast food restaurants off base during work hours in the last 7 days? _____times

16. How many times did you eat food from "sit down" restaurants off base during work hours in the last 7 days? _____times

17. How many times did you eat food from fast food restaurants off base outside of work hours in the last 7 days? _____times

18. How many times did you eat food from "sit down" restaurants off base outside of work hours in the last 7 days? ______times

19. How many times did you eat food from home outside of work hours in the last 7 days? _____times

PHYSICAL ACTIVITY

We are interested in finding out about the kinds of physical activities people do as part of their everyday lives. The following questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ **days per week**

   ☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don’t know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

   _____ **days per week**

   ☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don’t know/Not sure

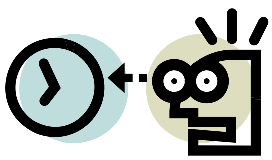
The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

STRESS 

Now we are going to switch gears and ask you some questions about stress. This next set of questions asks you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last month, how often have you been upset because of something that happened unexpectedly?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

2. In the last month, how often have you felt that you were unable to control the important things in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

3. In the last month, how often have you felt nervous and "stressed"?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

4. In the last month, how often have you felt confident about your ability to handle your personal problems?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

5. In the last month, how often have you felt that things were going your way?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

6. In the last month, how often have you found that you could not cope with all the things that you had to do?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

7. In the last month, how often have you been able to control irritations in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

8. In the last month, how often have you felt that you were on top of things?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

9. In the last month, how often have you been angered because of things that were outside of your control?

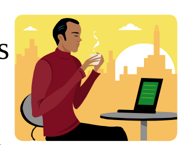
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

<u>WORK</u>

Now we are going to ask you about different aspects of your work and job.



1. In the past 7 days, how many <u>days</u> did you work <u>on base</u>? _________ days

2. In the past 7 days, how many <u>hours</u> did you work <u>on base</u>? _______hours

3. In the past 7 days, how many <u>nightshifts</u> did you work <u>on base</u>? _______nightshifts

4. On average, how many <u>minutes</u> does it take for you to <u>get to work</u> (i.e., time you leave your house to time you get to your building)?________ minutes

5. On average, how many minutes does it take for you to get home from work (i.e., time you leave your building to time you get home)?_______minutes

6. What is your duty status?

___ Active duty
___ National Guard
___ Reserve

7. If you are in the Guard or Reserve, how long have you been working full-time at Andrews AFB? (Active duty leave this question blank.)
____Years, ____Months, ____Weeks

8. What is your military rank?

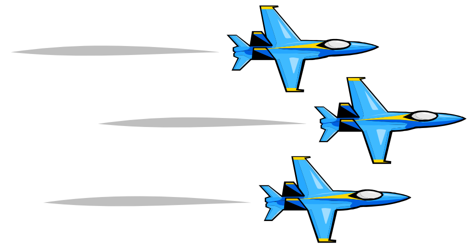
Enlisted	Officer
___ E-1 AB	___ O-1 2d Lt
___ E-2 Amn	___ O-2 1st Lt
___ E-3 A1C	___ O-3 Capt
___ E-4 SrA	___ O-4 Maj
___ E-5 SSgt	___ O-5 Lt Col
___ E-6 TSgt	___ O-6 Col
___ E-7 MSgt	___ O-7 Brig Gen
___ E-8 SMSgt	___ O-8 Maj Gen
___ E-9 CMSgt	___ O-9 Lt Gen

9. Which building do you work in on base?

___ 316th Headquarters (Bldg 3755)
___ 89th Headquarters (Bldg 1419)
___ Hospital (Bldg 1050)
___ Communications (Bldg 1558)
___ Air Refueling Wing (Bldg 3755)
___ Civil Engineering (Bldg 3465)
___ Airlift (Bldg 3252)
___ Supply (Bldg 3066)
___ CA Readiness (Bldg 2495)
___ Small Arms Range (Bldg 2350)
___ Kennel
___ Other (please specify): _________________

10. What is your Military Job/Occupation?

___ Administration
___ Communications/Intelligence
___ Logistics
___ Medical
___ Engineering/Maintenance
___ Operations
___ Security Forces
___ Supply and Service
___ Scientific/Professional
___ Support
___ Pilot
___ Other (please specify):________________



11. What is your Air Force Specialty Code (AFSC)?_____________

12. How many years of military service do you have? ____ years

13. How long have you been stationed at Andrews AFB? _____year(s) _____month(s)

14. Approximately <u>how much time</u> have you spent deployed, TDY, and on leave since you have been stationed at Andrews AFB?
____ Years, ____ Months, ____ Weeks, _____ Days

15. What is the approximate date of your last physical readiness test?
Month:___Year:_____

16. What was your score on your last physical readiness test? _____

17. What is the approximate date of your next physical readiness test?
Month:___ Year: _____

18. Which of the following statements <u>best</u> describes how your weight has changed <u>since you have been stationed at Andrews AFB</u>:

___ I have gained weight → How many pounds have you gained? ____pounds
___ I have lost weight → How many pounds have you lost? ___pounds
___ My weight has stayed the same.

HEALTH, LIFESTYLE, AND DEMOGRAPHICS

This last set of questions asks you about your health, lifestyle, and demographic information.

1. Are you currently dieting in order to lose weight? ___Yes ___No

2. Do you currently smoke or use smokeless tobacco products (e.g., chewing tobacco)?
   ___ Yes ___ No

   If yes, how many cigarettes do you smoke per day on average? ____ cigarettes
   If yes, how much smokeless tobacco did you use per day on average? ________

3. Are you a former smoker?
   ___ Yes ___ No

   If yes, when did you last smoke regularly? Month: ____ Year:______
   If yes, how many cigarettes did you smoke per day on average? ____ cigarettes
   If yes, how much smokeless tobacco did you use per day on average? ________

4. Have you been diagnosed with any of the following health conditions? Check all that apply.
   ___ Hypertension
   ___ Diabetes
   ___ Thyroid Disease
   ___ Other (please specify): ______________________________

5. Do you have any dietary restrictions? Check all that apply.
   ___ Food allergies
   ___ Vegetarian
   ___ Religious
   ___ Other

6. Gender:
   __ Male
   __ Female

7. Age: _____

8. Ethnicity:
   ___ Hispanic or Latino
   ___ Not Hispanic or Latino

9. Race (check all that apply):

___ American Indian or Alaska Native
___ Asian
___ Black or African American
___ Native Hawaiian or Pacific Islander
___ White
___ Some other race (please specify): ________________________

10. What is the highest level of education or year of school you have completed?

___ Less than 12 years of school
___ Grade 12 or GED (High School Graduate)
___ Some college or technical school
___ Bachelor's degree
___ Some graduate or professional training
___ Advanced degree (graduate or professional school)

11. What is your current marital status?

___ Never married
___ Married
___ Widowed
___ Divorced
___ Separated

12. Where do you currently live?

___ Dormitory
___ Base housing – West Side of Base
___ Base housing – East Side of Base
___ Off base

END OF SURVEY.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY.

Appendix D: Height/Weight Assessment Sheet

Participant # (On Front Page of Survey)	**Height** (inches)	**Weight** (pounds)	**Time Assessed** (B = Before survey, A = After survey)

Appendix E: Letter of Appreciation

Dear Air Force Member,

Thank you for participating in this research study designed to better understand how the base food environment may influence eating behavior and weight status among Air Force personnel. It is hoped that the findings of this study will help inform base leadership on how to modify the base food environment in order to promote the health of Air Force personnel and promote mission readiness.

If desired, you also may receive a written summary of the study findings by providing us with an e-mail address that we can reach you at in approximately 6 months from now.

Should you have questions about this study at any time, feel free to contact the principal investigator of the study at 301-775-5341.

Sincerely,

Crescent A. Seibert, M.S.
Graduate Student
Uniformed Services University of the Health Sciences
Bethesda, MD 20814-4799

References

Air Force Personnel Center (2009). Air Force Demographics. Retrieved February 21, 2009, from http://www.afpc.randolph.af.mil/library/airforcepersonnelstatistics.asp

Algert, S. J., Agrawal, A., & Lewis, D. S. (2006). Disparities in access to fresh produce in low-income neighborhoods in Los Angeles. *American Journal of Preventive Medicine, 30*(5), 365-370.

American College of Sports Medicine (2007). Physical Activity and Public Health Guidelines. Retrieved February 21, 2009, from http://www.acsm.org/AM/Template.cfm?Section=Home_Page&TEMPLATE=/CM/HTMLDisplay.cfm&CONTENTID=7764.

Anderson, D. A., Shapiro, J. R., Lundgren, J. D., Spataro, L. E., & Frye, C. A. (2002). Self-reported dietary restraint is associated with elevated levels of salivary cortisol. *Appetite, 38*(1), 13-17.

Andrews AFB (2007). Andrews Air Force Base Home Page. Retrieved September 5, 2007, from http://www.andrews.af.mil/

Apparicio, P., Cloutier, M. S., & Shearmur, R. (2007). The case of Montreal's missing food deserts: evaluation of accessibility to food supermarkets. *International Journal of Health Geographics, 6*, 4.

Astrup, A. (2005). Super-sized and diabetic by frequent fast-food consumption? *Lancet, 365*(9453), 4-5.

Baumgartner, N. (2003). Rationale for Proposed Air Force Physical Fitness Program. Retrieved February 25, 2009, from http://www.hill.af.mil/shared/media/document/AFD-070122-020.doc

Berke, E. M., Koepsell, T. D., Moudon, A. V., Hoskins, R. E., & Larson, E. B. (2007). Association of the built environment with physical activity and obesity in older persons. *American Journal of Public Health, 97*(3), 486-492.

Billings, C. E. (2004). Epidemiology of injuries and illnesses during the United States Air Force Academy 2002 Basic Cadet Training program: Documenting the need for prevention. *Military Medicine, 169*(8), 664-670.

Binkley, J. K., Eales, J., & Jekanowski, M. (2000). The relation between dietary change and rising US obesity. *International Journal of Obesity, 24*(8), 1032-1039.

Block, G., Gillespie, C., Rosenbaum, E. H., & Jenson, C. (2000). A rapid food screener to assess fat and fruit and vegetable intake. *American Journal of Preventive Medicine, 18*(4), 284-288.

Booth, K. M., Pinkston, M. M., & Poston, W. S. (2005). Obesity and the built environment. *Journal of the American Dietetic Association, 105*(5 Suppl 1), S110-117.

Bowman, S. A., & Vinyard, B. T. (2004). Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. *Journal of the American College of Nutrition, 23*(2), 163-168.

Bradham, D. D., South, B. R., Saunders, H. J., Heuser, M. D., Pane, K. W., & Dennis, K. E. (2001). Obesity-related hospitalization costs to the U.S. Navy, 1993-1998. *Military Medicine, 166*(1), 1-10.

Bray, G. A., & Popkin, B. M. (1998). Dietary fat intake does affect obesity! *American Journal of Clinical Nutrition, 68*(6), 1157-1173.

Bray, R. M., Hourani, L. L., Rae Olmsted, K. L., Witt, M., Brown, J., Pemberton, M. R., et al. (2007). *2005 Department of Defense Survey of Health Related Behaviors Among Military Personnel*. Research Triangle Park: RTI International. Retrieved May 5, 2008, from http://www.ha.osd.mil/special_reports/2005_Health_Behaviors_Survey_1-07.pdf

Bray, R. M., Rae Olmstead, K. L., Williams, J., Sanchez, R. P., & Hartzell, M. (2006). Progress toward healthy people 2000 objectives among U.S. military personnel. *Preventive Medicine*, *42*(5), 390-396.

Brownell, K. D. (2007, October). How best can behavioral medicine facilitate practical research with a goal of reversing the childhood obesity epidemic? In P. A. Estabrooks and L. L. Hayman (Moderators), *Special session and town hall forum on obesity*. Symposium conducted at the 28th annual meeting of the Society of Behavioral Medicine, Washington, DC.

Brownell, K. D., & Horgen, K. B. (2004). *Food Fight: The Inside Story of the Food Industry, America's Obesity Crisis, and What We Can Do About It*. New York: McGraw-Hill.

Brownson, R. C., Chang, J. J., Eyler, A. A., Ainsworth, B. E., Kirtland, K. A., Saelens, B. E., et al. (2004). Measuring the environment for friendliness toward physical activity: a comparison of the reliability of 3 questionnaires. *American Journal of Public Health*, *94*(3), 473-483.

Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Preventive Medicine*, *38*(1), 57-63.

Carlton, J. R., Manos, G. H., & Van Slyke, J. A. (2005). Anxiety and abnormal eating behaviors associated with cyclical readiness testing in a naval hospital active duty population. *Military Medicine*, *170*(8), 663-667.

Cash, T. F., Grant, J. R., Shovlin, J. M., & Lewis, R. J. (1992). Are inaccuracies in self-reported weight motivated distortions? *Perceptual and Motor Skills, 74*(1), 209-210.

Center for Disease Control and Prevention (2007). *Overweight and obesity: Frequently asked questions.* Retrieved January 21, 2007, from http://www.cdc.gov/nccdphp/dnpa/obesity/faq.htm#difference

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*, 385-396.

Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the U.S. In S. Spacapam & S. Oskamp (Eds.), *The social psychology of health: Claremont Symposium on Applied Social Psychology*. Newbury Park, CA: Sage.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise, 35*(8), 1381-1395.

Critser, G. (2003). *Fat Land*. London: Penguin Books.

Davison, K. K., & Lawson, C. T. (2006). Do attributes in the physical environment influence children's physical activity? A review of the literature. *International Journal of Behavioral Nutrition and Physical Activity, 3,* 19.

Dearry, A. (2004). Impacts of our built environment on public health. *Environmental Health Perspectives, 112*(11), A600-601.

Dehghan, M., Akhtar-Danesh, N., & Merchant, A. T. (2005). Childhood obesity, prevalence and prevention. *Nutrition Journal, 4,* 24.

DMPC (2005). Defense Manpower Data Center. Military Demographics. Retrieved February 25, 2009, from http://www.defenselink.mil/prhome/poprep2005/summary/summary.html

Drewnowski, A. (1997). Taste preferences and food intake. *Annual Review of Nutrition, 17,* 237-253.

Drewnowski, A., & Darmon, N. (2005). Food choices and diet costs: an economic analysis. *Journal of Nutrition, 135*(4), 900-904.

Drewnowski, A., & Rolls, B. J. (2005). How to modify the food environment. *Journal of Nutrition, 135*(4), 898-899.

Drewnowski, A., & Specter, S. E. (2004). Poverty and obesity: the role of energy density and energy costs. *American Journal of Clinical Nutrition, 79*(1), 6-16.

Duffey, K. J., Gordon-Larsen, P., Jacobs, D. R., Jr., Williams, O. D., & Popkin, B. M. (2007). Differential associations of fast food and restaurant food consumption with 3-y change in body mass index: the Coronary Artery Risk Development in Young Adults Study. *American Journal of Clinical Nutrition, 85*(1), 201-208.

Egger, G., & Swinburn, B. (1997). An "ecological" approach to the obesity pandemic. *British Medical Journal, 315*(7106), 477-480.

Ello-Martin, J. A., Roe, L. S., Meengs, J. S., Wall, D. E., & Rolls, B. J. (2002). Increasing the portion size of a unit food increases energy intake. *Appetite, 39*, 74.

Ewing, R., Brownson, R. C., Berrigan, D. (2006). Relationship between urban sprawl and weight of United States youth. *American Journal of Preventive Medicine, 31*(6), 464-474.

Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., & Raudenbush, S. (2003). Relationship between urban sprawl and physical activity, obesity, and morbidity. *American Journal of Health Promotion, 18,* 47-57.

Field, A. (2005). *Discovering Statistics Using SPSS* (2nd ed.). London: Sage Publications.

Field, A. E., Cook, N. R., & Gillman, M. W. (2005). Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. *Obesity Research, 13*(1), 163-169.

Finkelstein, E. A., Fiebelkorn, I. C., & Wang, G. (2004). State-level estimates of annual medical expenditures attributable to obesity. *Obesity Research, 12*(1), 18-24.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Johnson, C. L. (2002). Prevalence and trends in obesity among US adults, 1999-2000. *Journal of the American Medical Association, 288*(14), 1723-1727.

Frank, L. D., Andresen, M. A., & Schmid, T. L. (2004). Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine, 27*(2), 87-96.

Frank, L. D., Saelens, B. E., Powell, K. E., & Chapman, J. E. (2007). Stepping towards causation: Do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity?, *Social Science & Medicine, 65,* 1898-1914.

Freedman, D. S., Ogden, C. L., K., F., Khan, L. K., Serdula, M. K., & Dietz, W. H. (2007). Childhood overweight and family income. *Clinical Nutrition and Obesity, 9*(2), 26.

French, S. A. (2005). Public health strategies for dietary change: schools and workplaces. *Journal of Nutrition, 135*(4), 910-912.

French, S. A., Harnack, L., & Jeffery, R. W. (2000). Fast food restaurant use among women in the Pound of Prevention study: dietary, behavioral and demographic correlates. *International Journal of Obesity and Related Metabolic Disorders. Journal of the International Association for the Study of Obesity, 24*(10), 1353-1359.

French, S. A., Jeffrey, R. W., Story, M., Breitlow, K. K., Baxter, J. S., Hannan, P., et al., (2001). Pricing and promotion effects on low-fat vending snack purchases: The CHIPS Study, *American Journal of Public Health, 91*: 112-117.

French, S. A., Story, M., & Jeffery, R. W. (2001). Environmental influences on eating and physical activity. *Annual Review of Public Health, 22,* 309-335.

French, S. A., Story, M., Jeffery, R. W., Snyder, P., Eisenberg, M., Sidebottom, A., et al. (1997). Pricing strategy to promote fruit and vegetable purchase in high school cafeterias. *Journal of the American Dietetic Association, 97*(9), 1008-1010.

French, S. A., Story, M., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders. Journal of the International Association for the Study of Obesity, 25*(12), 1823-1833.

Friedl, K. E., & Vogel, J. A. (1997). Validity of percent body fat predicted from circumferences: Classification of men for weight control regulations. *Military Medicine, 162*(3), 194-200.

Garmin (1999). *Garmin GPS handheld products specifications*. Retrieved September 15, 2007, from https://buy.garmin.com/shop/store/assets/pdfs/specs/gps12series_spec.pdf

Giles-Corti, B., Broomhall, M. H., Knuiman, M., Collins, C., Douglas, K., Ng, K., et al. (2005). Increasing walking: how important is distance to, attractiveness, and size of public open space? *American Journal of Preventive Medicine, 28*(2 Suppl 2), 169-176.

Glanz, K., Basil, M., Maibach, E., Goldberg, J., & Snyder, D. (1998). Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *Journal of the American Dietetic Association, 98*(10), 1118-1126.

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research, 26*(3), 499-510.

Hallal, P. C., & Victora, C. G. (2004). Reliability and validity of the International Physical Activity Questionnaire (IPAQ). *Medicine and Science in Sports and Exercise, 36*(3), 556.

Hannan, P., French, S. A., Story, M., & Fulkerson, J. A. (2000). A pricing strategy to promote purchase of lower fat foods in a high school cafeteria: acceptability and sensitivity analysis. *American Journal of Health Promotion, 17:* 1-6.

Heetderks-Cox, J. (2008, July). 88 MDG Nutritional Medicine foodservice initiatives to prevent weight creep. In *Warfighter Nurtition: Advanced Technologies and Opportunities.* Symposium conducted at Uniformed Services University of the Health Sciences, Bethesda, MD.

Hill, J. O., & Peters, J. C. (1998). Environmental contributions to the obesity epidemic. *Science, 280*, 1371-1374.

Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the environment: where do we go from here? *Science, 299*(5608), 853-855.

Horgen, K. B., & Brownell, K. D. (2002). Comparison of price change and health message interventions in promoting healthy food choices. *Health Psychology, 21*(5), 505-512.

Hsu, L. L., Nevin, R. L., Tobler, S. K., & Rubertone, M. V. (2007). Trends in overweight and obesity among 18 year-old applicants to the United States military, 1993-2006. *The Journal of Adolescent Health, 41*(6), 610-612.

Hunter, C. (2005). *Health Education and Lifestyle Initiative for Optimal Service study*. Paper presented at the annual meeting of NAASO, The Obesity Society, Vancouver, British Columbia.

Inagami, S., Cohen, D. A., Finch, B. K., & Asch, S. M. (2006). You are where you shop. *American Journal of Preventive Medicine, 31*(1), 10-17.

IOM. (2004). *Institute of Medicine of the National Academies: Weight management: State of the science and opportunities for military programs.* Washington, DC: The National Academies Press.

Institute of Medicine. (1998). *Assessing Readiness in Military Women: The Relationship of Body Composition, Nutrition, and Health.* Washington, DC: National Academy Press.

IPAQ (2005). Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire. Retrieved April 5, 2007, from http://www.ipaq.ki.se/scoring.pdf

IPAQ (2002). Short Last 7 Days Self-Administered Version of the IPAQ. Short form Word. Retrieved April 5, 2007, from http://www.ipaq.ki.se/downloads.htm

Jaeger, S. R., & Cardello, A. V. (2007). A construct analysis of meal convenience applied to military foods. *Appetite, 49*(1), 231-239.

James, L. C., Folen, R. A., Garland, F. N., Edwards, C., Noce, M., Gohdes, D., et al. (1997). The Tripler Army Medical Center LEAN Program: a healthy lifestyle model for the treatment of obesity. *Military Medicine, 162*(5), 328-332.

Jeffery, R. W., Baxter, J., McGuire, M., & Linde, J. (2006). Are fast food restaurants an environmental risk factor for obesity? *International Journal of Behavioral Nutrition and Physical Activity, 3*, 2.

Kant, A. K. (2000). Consumption of energy-dense, nutrient-poor foods by adult Americans: nutritional and health implications. The third National Health and Nutrition Examination Survey, 1988-1994. *American Journal of Clinical Nutrition*, *72*(4), 929-936.

King, W. C., Belle, S. H., Brach, J. S., Simkin-Silverman, L. R., Soska, T., & Kriska, A. M. (2005). Objective measures of neighborhood environment and physical activity in older women. *American Journal of Preventive Medicine, 28*(5), 461-469.

Kipke, M. D., Iverson, E., Moore, D., Booker, C., Ruelas, V., Peters, A. L., et al. (2007). Food and park environments: Neighborhood-level risks for childhood obesity in east Los Angeles. *Journal of Adolescent Health, 40*(4), 325-333.

Lauder, T. D., & Campbell, C. S. (2001). Abnormal eating behaviors in female reserve officer training corps cadets. *Military Medicine, 166*(3), 264-268.

Lauder, T. D., Williams, M. V., Campbell, C. S., Davis, G. D., & Sherman, R. A. (1999). Abnormal eating behaviors in military women. *Medicine & Science in Sports & Exercise, 31*(9), 1265-1271.

Ledikwe, J. H., Ello-Martin, J. A., & Rolls, B. J. (2005). Portion sizes and the obesity epidemic. *Journal of Nutrition, 135*(4), 905-909.

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: using geographic information systems to objectively assess relevant environmental attributes. *Health Place, 13*(1), 111-122.

Lindquist, C. H., & Bray, R. M. (2001). Trends in overweight and physical activity among U.S. military personnel, 1995-1998. *Preventive Medicine, 32*(1), 57-65.

Lopez-Zetina, J., Lee, H., & Friis, R. (2006). The link between obesity and the built environment. Evidence from an ecological analysis of obesity and vehicle miles of travel in California. *Health Place, 12*(4), 656-664.

Lowe, M. R. (1993). The effects of dieting on eating behavior: a three-factor model. *Psychological Bulletin, 114*(1), 100-121.

Lowe, M. R., Annunziato, R. A., Markowitz, J. T., Didie, E., Bellace, D. L., Riddell, L., et al. (2006). Multiple types of dieting prospectively predict weight gain during the freshman year of college. *Appetite, 47*(1), 83-90.

Lueck, T., & Severson, K. (2006, December 6). New York bans most trans fats in restaurants. *New York Times.* Retrieved June 11, 2007, from http://www.nytimes.com/2006/12/06/nyregion/06fat.html?ex=1181707200&en=a416af980746a517&ei=5070

Maddock, J. (2004). The relationship between obesity and the prevalence of fast food restaurants: state-level analysis. *American Journal of Health Promotion, 19*(2), 137-143.

Marmonier, C., Chapelot, M. F., & Louis-Sylvestre, J. (2002). Snacks consumed in a nonhungry state have poor satiating efficiency: Influence of snack consumption on substrate utilization and hunger. *American Journal of Clinical Nutrition, 76*(3), 518-528

McCann, B. S., Warnick, G. R., & Knopp, R. H. (1990). Changes in plasma lipids and dietary intake accompanying shifts in perceived workload and stress. *Psychosomatic Medicine, 52*, 97-108.

McCrory, M. A., Fuss, P. J., Hays, N. P., Vinken, A. G., Greenberg, A. S., & Roberts, S. B. (1999). Overeating in America: association between restaurant food consumption and body fatness in healthy adult men and women ages 19 to 80. *Obesity Research, 7*(6), 564-571.

McGinn, A. P., Evenson, K. R., Herring, A. H., Huston, S. L., & Rodriguez, D. A. (2007). Exploring Associations between Physical Activity and Perceived and Objective Measures of the Built Environment. *Journal of Urban Health, 84*(2), 162-184.

McNulty, P. A. (1997a). Prevalence and contributing factors of eating disorder behaviors in a population of female Navy nurses. *Military Medicine, 162*(10), 703-706.

McNulty, P. A. (1997b). Prevalence and contributing factors of eating disorder behaviors in active duty Navy men. *Military Medicine, 162*(11), 753-758.

McNulty, P. A. (2001). Prevalence and contributing factors of eating disorder behaviors in active duty service women in the Army, Navy, Air Force, and Marines. *Military Medicine, 166*(1), 53-58.

Mela, D. J. (2001). Determinants of food choice: relationships with obesity and weight control. *Obesity Research*, *9 Suppl 4*, 249S-255S.

Michael, Y., Beard, T., Choi, D., Farquhar, S., & Carlson, N. (2006). Measuring the influence of built neighborhood environments on walking in older adults. *Journal of Aging and Physical Activity*, *14*(3), 302-312.

Military Installation Guide (2007). Military Installation Guide. Retrieved September 7, 2007, from http://www.miltary.com

Miller, W. R., & Rollnick, S. (2002). *Motivational interviewing: Preparing people for change* (2nd ed.). New York: Guilford Press.

Mobley, L. R., Root, E. D., Finkelstein, E. A., Khavjou, O., Farris, R. P., & Will, J. C. (2006). Environment, obesity, and cardiovascular disease risk in low-income women. *American Journal of Preventive Medicine, 30*(4), 327-332.

Morland, K., Diez Roux, A., & Wing, S. (2006). Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. *American Journal of Prventive Medicine, 30*(4), 333-339.

Morland, K., Wing, S., & Diez Roux, A. (2002). The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. *American Journal of Public Health, 92*(11), 1761-1767.

National Quality Management Program (2003). *Prevalence of Obesity in the Direct Care System.* Retrieved September 4, 2005, from http://www.nqmp.info/ed/content/fact_fr.htm

Netrition (2009). Recommended Daily Intake. Retrieved January 3, 2009, from http://www.netrition.com/rdi_page.html

Nolte, R., Franckowiak, S. C., Crespo, C. J., & Andersen, R. E. (2002). U.S. military weight standards: What percentage of U.S. young adults meet the current standards? *The American Journal of Medicine, 113*(6), 486-490.

Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *Journal of the American Medical Association, 295*(13), 1549-1555.

Oliver, G., & Wardle, J. (1999). Perceived effects of stress on food choice. *Physiology & Behavior, 66*(3), 511-515.

Oliver, G., Wardle, J., & Gibson, E. L. (2000). Stress and food choice: a laboratory study. *Psychosomatic Medicine, 62*(6), 853-865.

P2R2 (2007). P2R2 Virtual Analyst. Retrieved April 27, 2007 from https://p2r2va.hq.af.mil

Papas, M. A., Alberg, A. J., Ewing, R., Helzlsouer, K. J., Gary, T. L., & Klassen, A. C. (2007). The Built Environment and Obesity. *Epidemiologic Review*.

Paris, R. M., Bedno, S. A., Krauss, M. R., Keep, L. W., & Rubertone, M. V. (2001). Weighing in on type 2 diabetes in the military: characteristics of U.S. military personnel at entry who develop type 2 diabetes. *Diabetes Care, 24*(11), 1894-1898.

Pate, R. R., Wang, C. Y., Dowda, M., Farrell, S. W., & O'Neill, J. R. (2006). Cardiorespiratory fitness levels among US youth 12 to 19 years of age: findings from the 1999-2002 National Health and Nutrition Examination Survey. *Archives of Pediatrics and Adolescent Medicine, 160*(10), 1005-1012.

Pereira, M. A., Kartashov, A. I., Ebbeling, C. B., Van Horn, L., Slattery, M. L., Jacobs, D. R., Jr., et al. (2005). Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet, 365*(9453), 36-42.

Pfizer Pharmaceuticals (1999). *Health Status of the U.S. Army: Findings from the Total Army Injury and Health Outcomes Database.* Retrieved September 4, 2005, from http://www.usariem.army.mil/download/usarmystatus.pdf

Prentice, A. M., & Jebb, S. A. (2003). Fast foods, energy density and obesity: a possible mechanistic link. *Obesity Review, 4*(4), 187-194.

Robbins, A. S., Chao, S. Y., Fonseca, V. P., Snedecor, M. R., & Knapik, J. J. (2001). Predictors of low physical fitness in a cohort of active-duty U.S. Air Force members. *American Journal of Preventive Medicine, 20*(2), 90-96.

Robbins, A. S., Chao, S. Y., Russ, C. R., & Fonseca, V. P. (2002). Costs of excess body weight among active duty personnel, U.S. Air Force, 1997. *Military Medicine, 167*(5), 393-397.

Rolls, B. J., Morris, E. L., & Roe, L. S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *American Journal of Clinical Nutrition, 76*(6), 1207-1213.

Sallis, J. F., Bauman, A., & Pratt, M. (1998). Environmental and policy interventions to promote physical activity. *American Journal of Preventive Medicine, 15*, 379-397.

Schoenborn, C. A. (2004). Marital status and health: United States, 1999-2002. *Advance Data*(351), 1-32.

Seibert, C. A., Sbrocco, T., Hsiao, C. W., & Lewis, E. L. (2008). *Factors Associated with Unhealthy Weight Control Behavior Among Active Duty Military Personnel.* Manuscript submitted for publication.

Sigrest, L. D., Anderson, J. E., & Aulg, G. W. (2005). Senior military officers' educational concerns, motivators, and barriers for healthful eating and regular exercise. *Military Medicine, 170*(10), 841-845.

Skinner, B. (1953). Science and human behavior. New York: MacMillan.

Sproul, A. D., Canter, D. D., & Schmidt, J. B. (2003). Does point-of-purchase nutritional labeling influence meal selections? A test in an Army cafeteria. *Military Medicine, 168*(7), 566-560.

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a measure of the motives underlying the selection of food: The Food Choice Questionnaire. *Appetite*, *25*, 267-284.

Swinburn, B., & Egger, G. (2002). Preventive strategies against weight gain and obesity. *Obesity Reviews*, *3*, 289-301.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting obesogenic environments: The development and application of a frame work for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine, 29*, 563-570.

SYE (2004). Shape Your Future Your Weigh: Healthier Vending and Snack Bar Options. Retrieved January 3, 2009, from https://kx.afms.mil/kxweb/dotmil/file/web/ctb_105496.pdf

SYE (2007). Shape Your Environment Your Weigh Assessment Tool. Air Force Medical Service. Retrieved January 2, 2009, from https://kx.afms.mil/kxweb/dotmil/file/web/ctb_079349.pdf

Torres, S. J., & Nowson, C. A. (2007). Relationship between stress, eating behavior, and obesity. *Nutrition*.

Townsend, M. S. (2006). Obesity in low-income communities: prevalence, effects, a place to begin. *Journal of the American Dietetic Association, 106*(1), 34-37.

Troped, P. J., Saunders, R. P., Pate, R. R., Reininger, B., Ureda, J. R., & Thompson, S. J. (2001). Associations between self-reported and objective physical environmental factors and use of a community rail-trail. *Preventive Medicine*, *32*, 191-200.

Troumbley, P. F., Rinke, W. J., Burman, K. D., & Lenz, E. R. (1990). A comparison of the health risk, health status, self-motivation, psychological symptomatic distress, and physical fitness of overweight and normal-weight soldiers. *Military Medicine, 155*, 424-429.

U.S. Department of the Air Force (1994). Air Force Instruction 40-502. "The Weight Management Program." November 7. Washington, D.C.

U.S. Department of the Air Force (2006). *Air Force Instruction 10-248: Fitness Program.* Retrieved February 20, 2007, from http://www.e-publishing.af.mil

U.S. Department of the Air Force (2004). *Air Force Instruction 34-239: Food Service Management Program.* February 20. Washington, D.C.

U.S. Department of the Air Force (2005). *Air Force Manual 34-240: Food Service Program Management.* May 2. Washington, D.C.

U.S. Department of Defense (1981). Department of Defense Directive 1308.1. "Physical Fitness and Weight Control Programs." June 29. Washington, D.C.

U.S. Department of Defense (2004). *DoD Instruction 1308.1: DoD Physical Fitness and Body Fat Program.* Retrieved August 25, 2005, from http://www.dtic.mil/whs/directives/corres/html/13081.htm

U.S. Department of Transportation (2007). *Neo-Traditional Neighborhood Design.* Retrieved September 10, 2007, from http://safety.fhwa.dot.gov/ped_bike/univcourse/swless06.htm

van Lenthe, F. J., & Mackenbach, J. P. (2002). Neighbourhood deprivation and overweight: the GLOBE study. *International Journal of Obesity and Related Metabolic Disorders. Journal of the International Association for the Study of Obesity, 26*(2), 234-240.

Vartanian, L. R., Schwartz, M. B., & Brownell, K. D. (2007). Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American Journal of Public Health, 97*(4), 667-675.

Wakefield, J. (2004). Fighting obesity through the built environment. *Environmental Health Perspectives, 112*(11), A616-618.

Wardle, J., Steptoe, A., Oliver, G., & Lipsey, Z. (2000). Stress, dietary restraint and food intake. *Journal of Psychosomatic Research, 48*(2), 195-202.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine, 337*(13), 869-873.

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health, 92*(2), 246-249.

Zakzanis, K. K. (2001). Statistics to tell the truth, the whole truth, and nothing but the truth: formulae, illustrative numerical examples, and heuristic interpretation of effect size analyses for neuropsychological researchers. *Archives of Clinical Neuropsychology, 16*(7), 653-667.

Zellner, D. A., Loaiza, S., Gonzalez, Z., Pita, J., Morales, J., Pecora, D., et al. (2006). Food selection changes under stress. *Physiology & Behavior, 87*(4), 789-793.

Zellner, D. A., Saito, S., & Gonzalez, J. (2007). The effect of stress on men's food selection. *Appetite.*

Zenk, S. N., Schulz, A. J., Israel, B. A., James, S. A., Bao, S., & Wilson, M. L. (2005). Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. *American Journal of Public Health*, *95*(4), 660-667.

Zhang, Q., & Wang, Y. (2004). Trends in the association between obesity and socioeconomic status in U.S. adults: 1971 to 2000. *Obesity Research, 12*(10), 1622-1632.

Zizza, C., Siega-Riz, A. M., & Popkin, B. M. (2001). Significant increase in young adults' snacking between 1977-1978 and 1994-1996 represents a cause for concern! *Preventive Medicine, 32*(4), 303-310.